Introduction to Core Data

Session 123

These are confidential sessions—please refrain from filming or taking pictures.

Application Technologies

Introduction to Core Data

Matthew Firlik
Manager, Core Data

http://developer.apple.com/wwdc2005/

What Is Core Data?

http://developer.apple.com/wwdc2005/

What Is Core Data?

Sometimes, a mouthful…

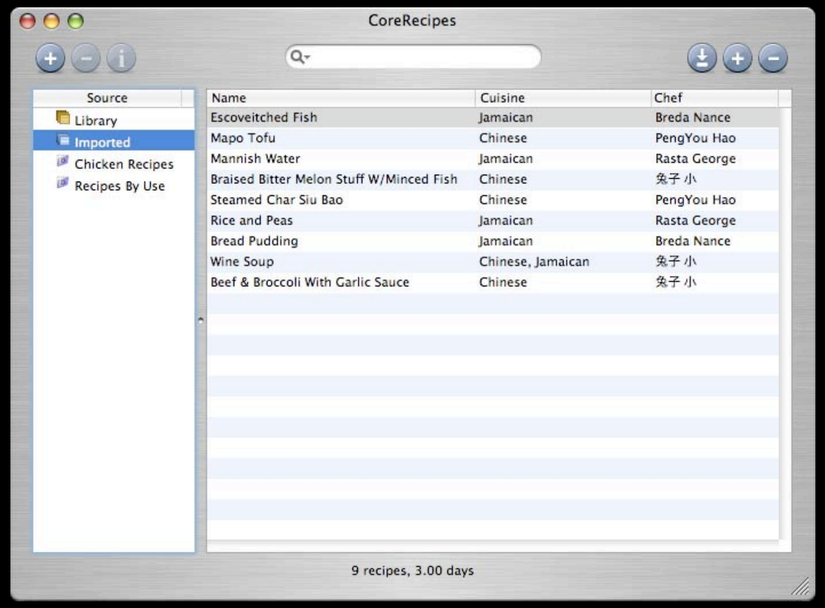
“Core Data completes the Cocoa vision for building well-factored applications based on the Model-View-Controller (MVC) pattern, and provides a strong, flexible, and powerful model-driven object graph management and persistency framework… “

- **Developing with Core Data**

  http://developer.apple.com/macosx/coredata

What Does Core Data Do?

Provides a framework to interact with your data



- Visualization and display
- Creation, modification, and deletion
- Save and retrieval

What Does Core Data Do?

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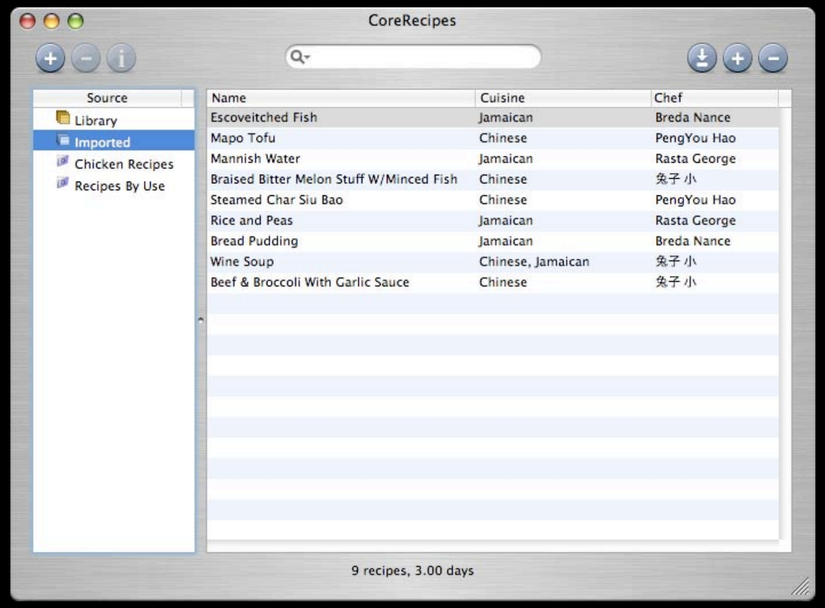

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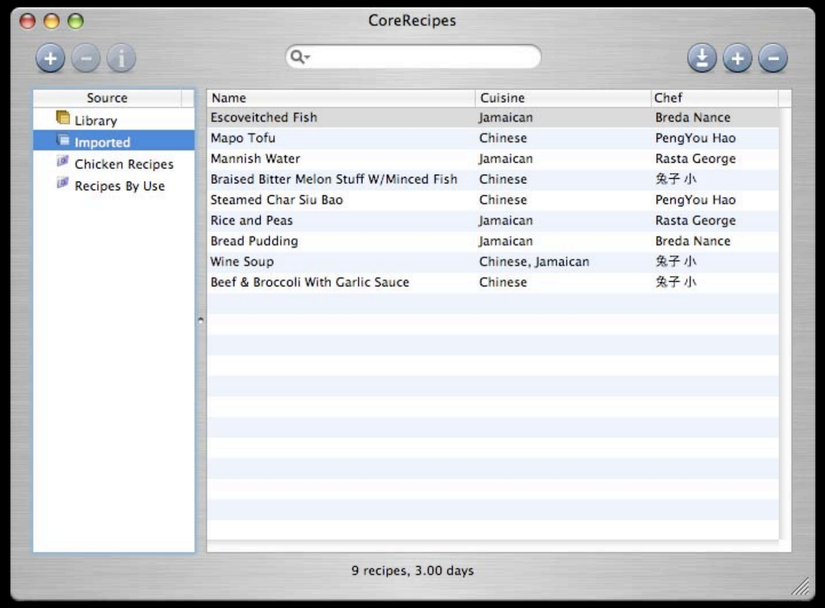
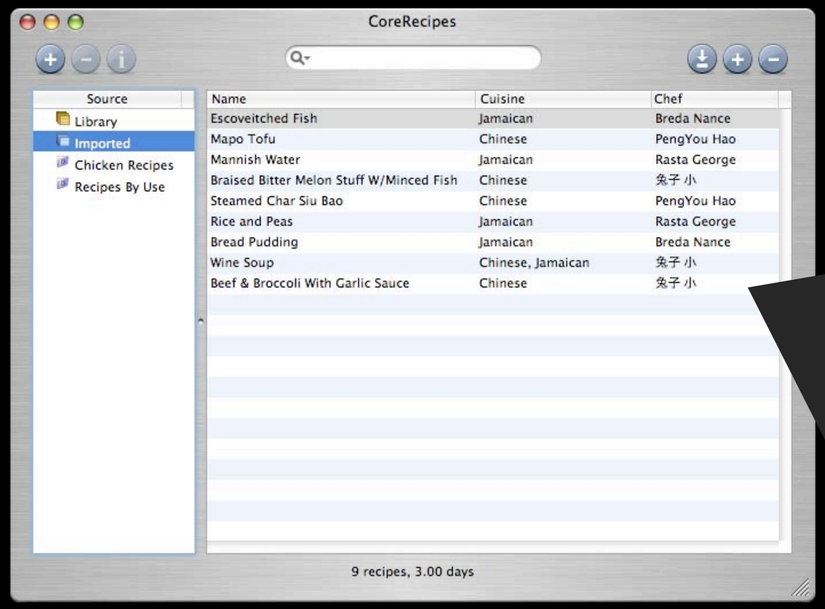
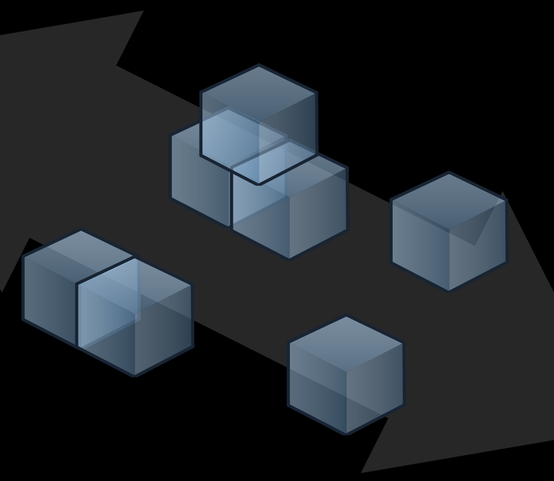


- Visualization and display
- Object (graph) management
- Persistence

What Does Core Data Do?

Down to the basics…



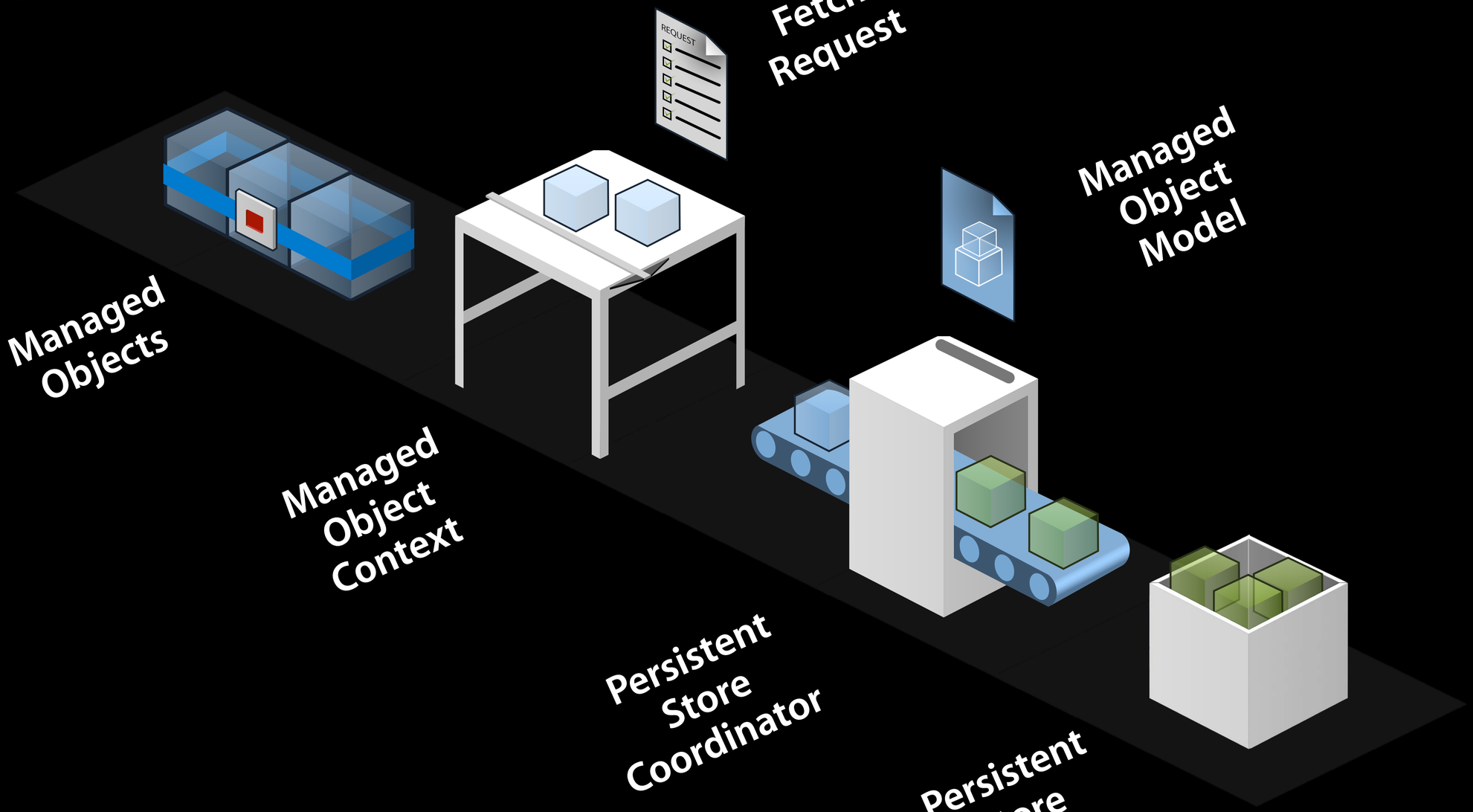


managed objects

```
<object type="RECIPE" id="z137">
     <attribute name="cookingtime"
 type="int16">10</attribute>
        <attribute
name="detaildescription"
type="string">A real treat for a
Sunday brunch.  We usually serve
this with a light sprinkle of
powdered sugar and warm maple
syrup.</attribute>
        <attribute name="name"
type="string">French Toast</
```

Core Data: The Architecture

The "persistence stack"



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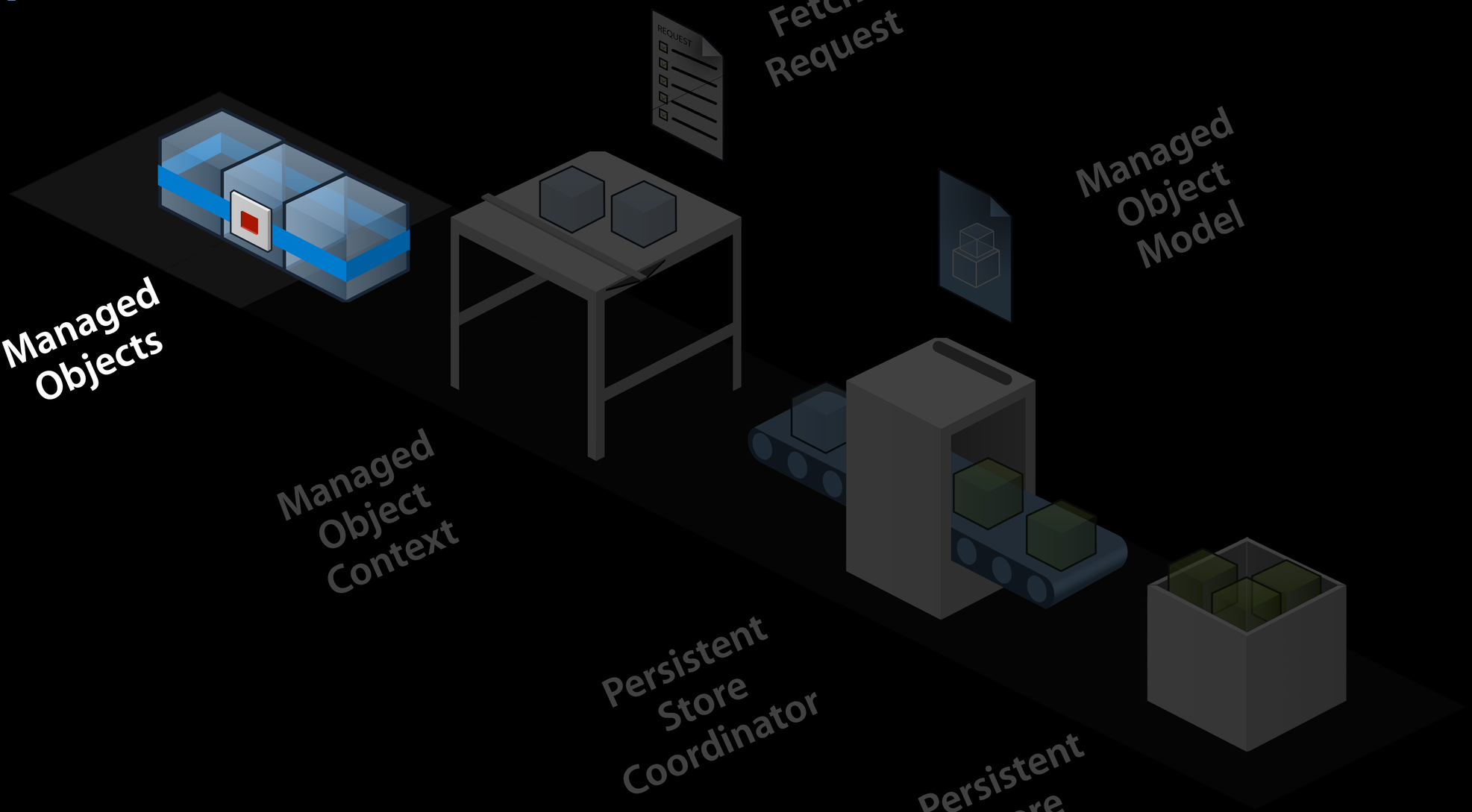

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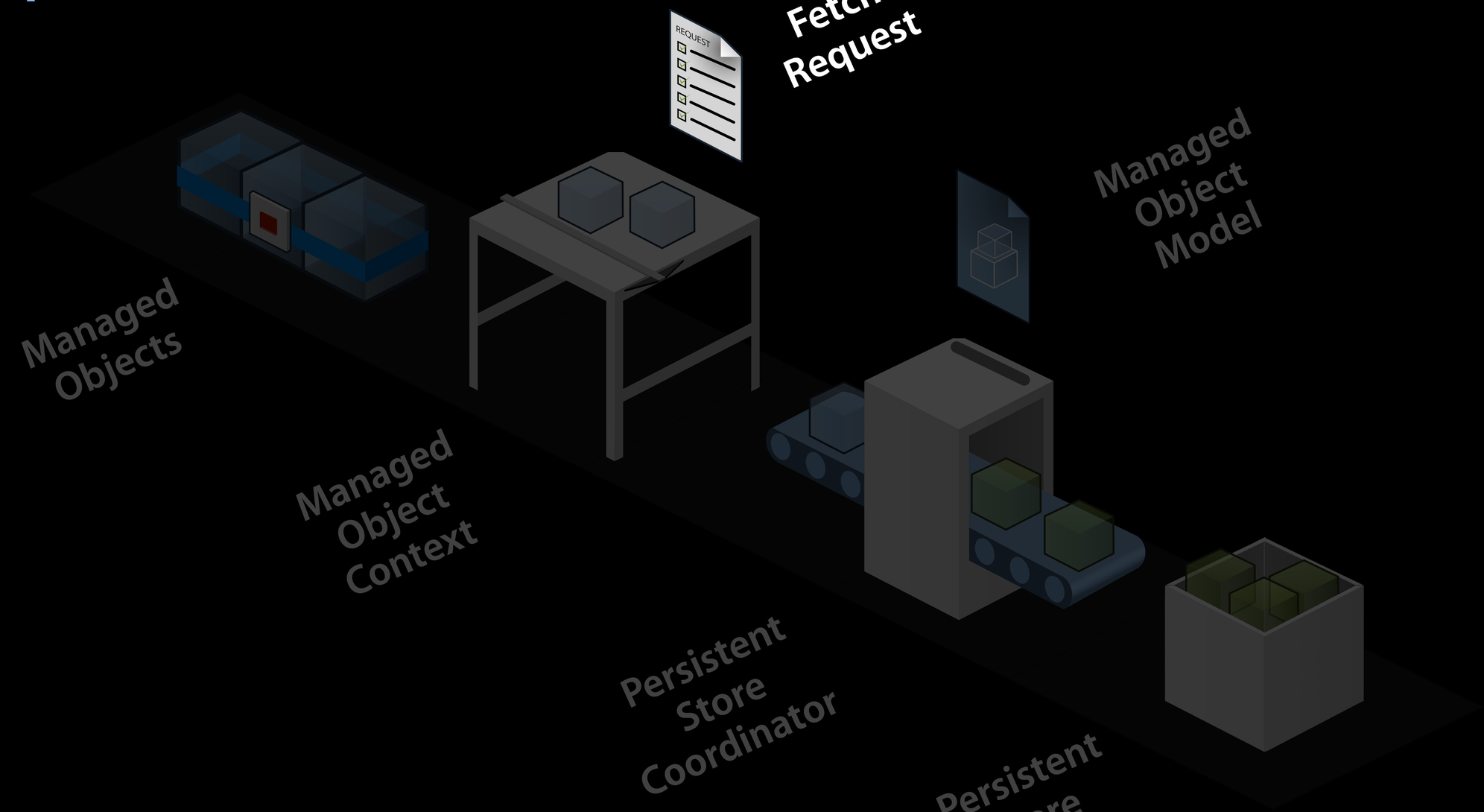

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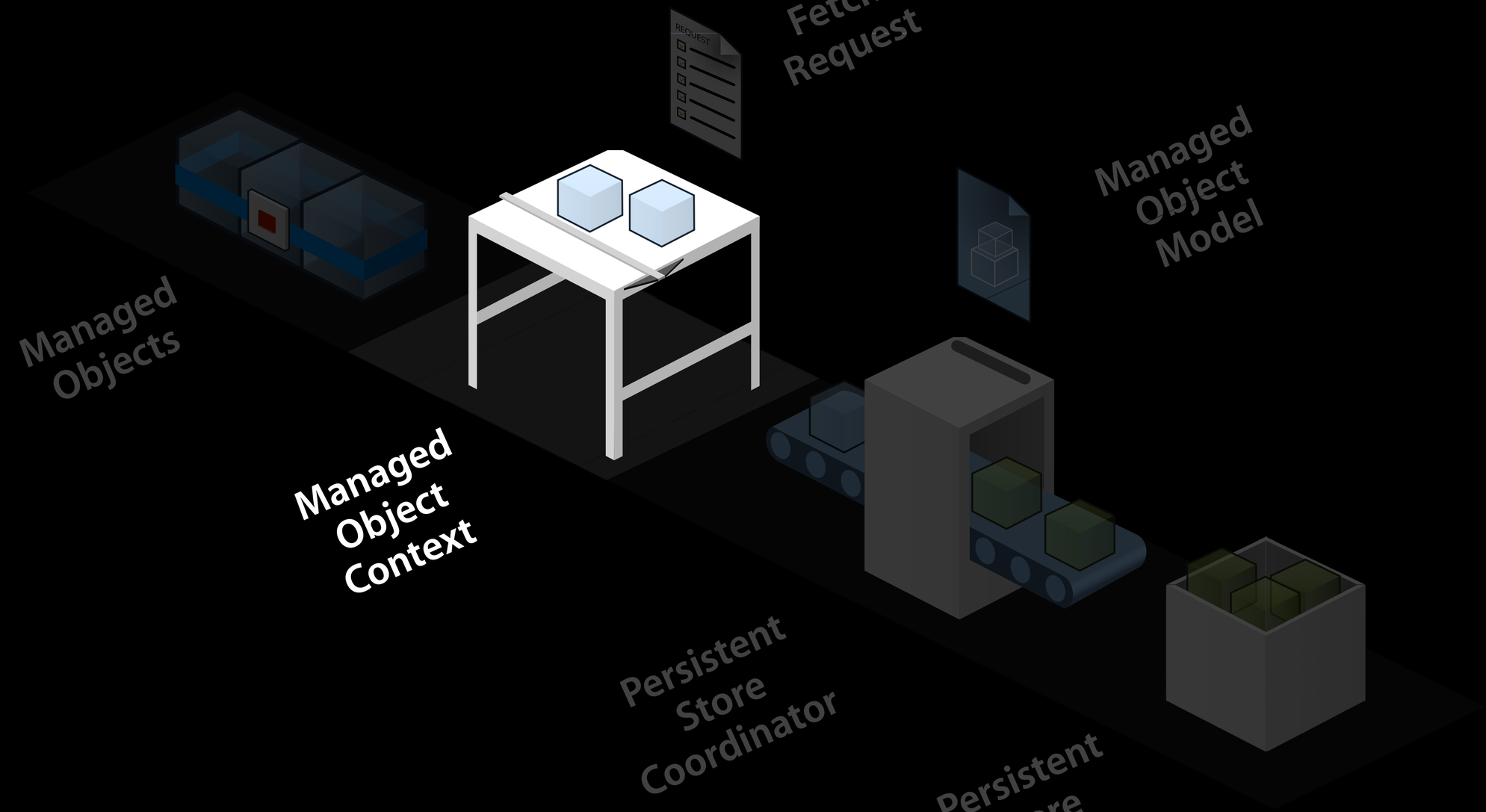

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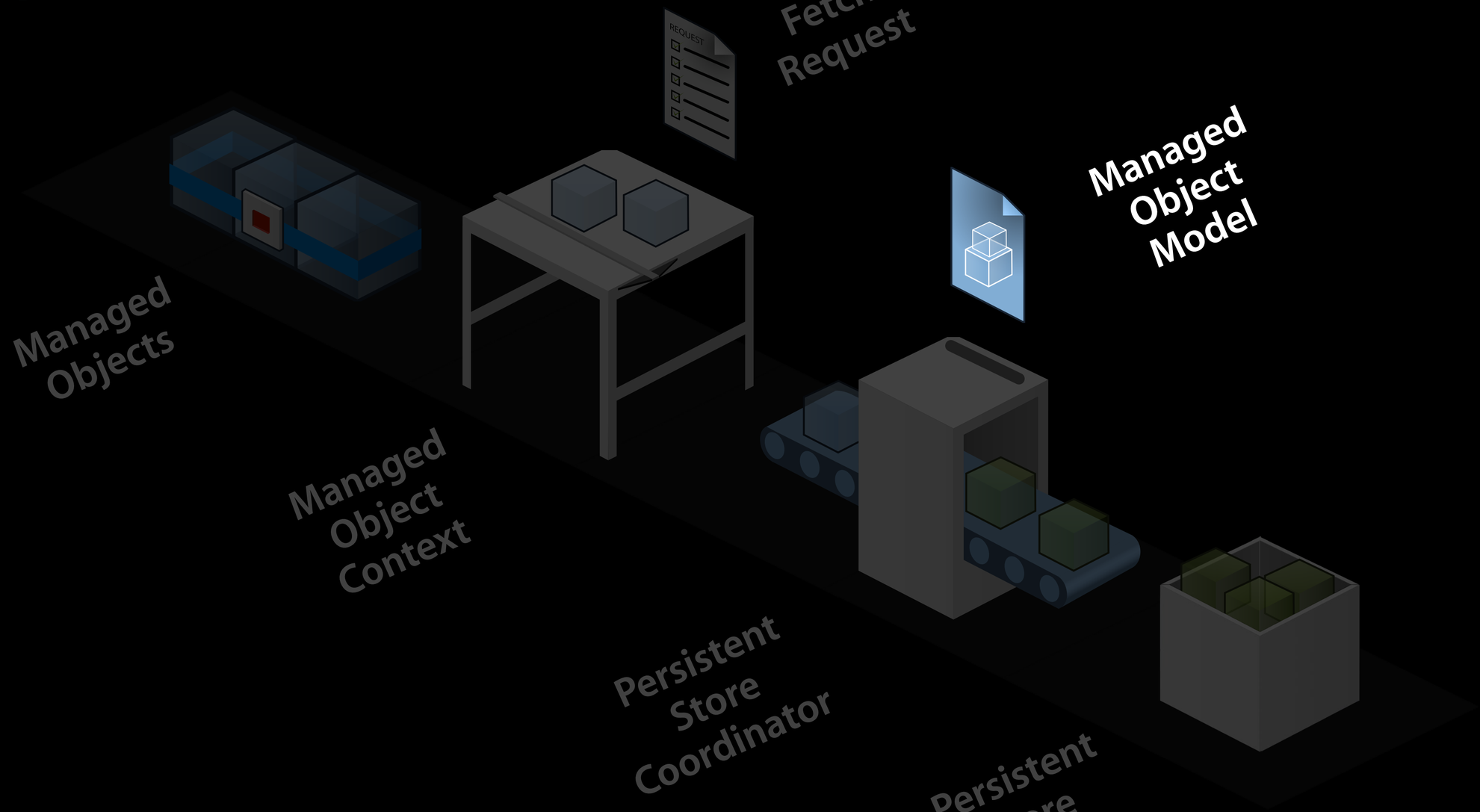

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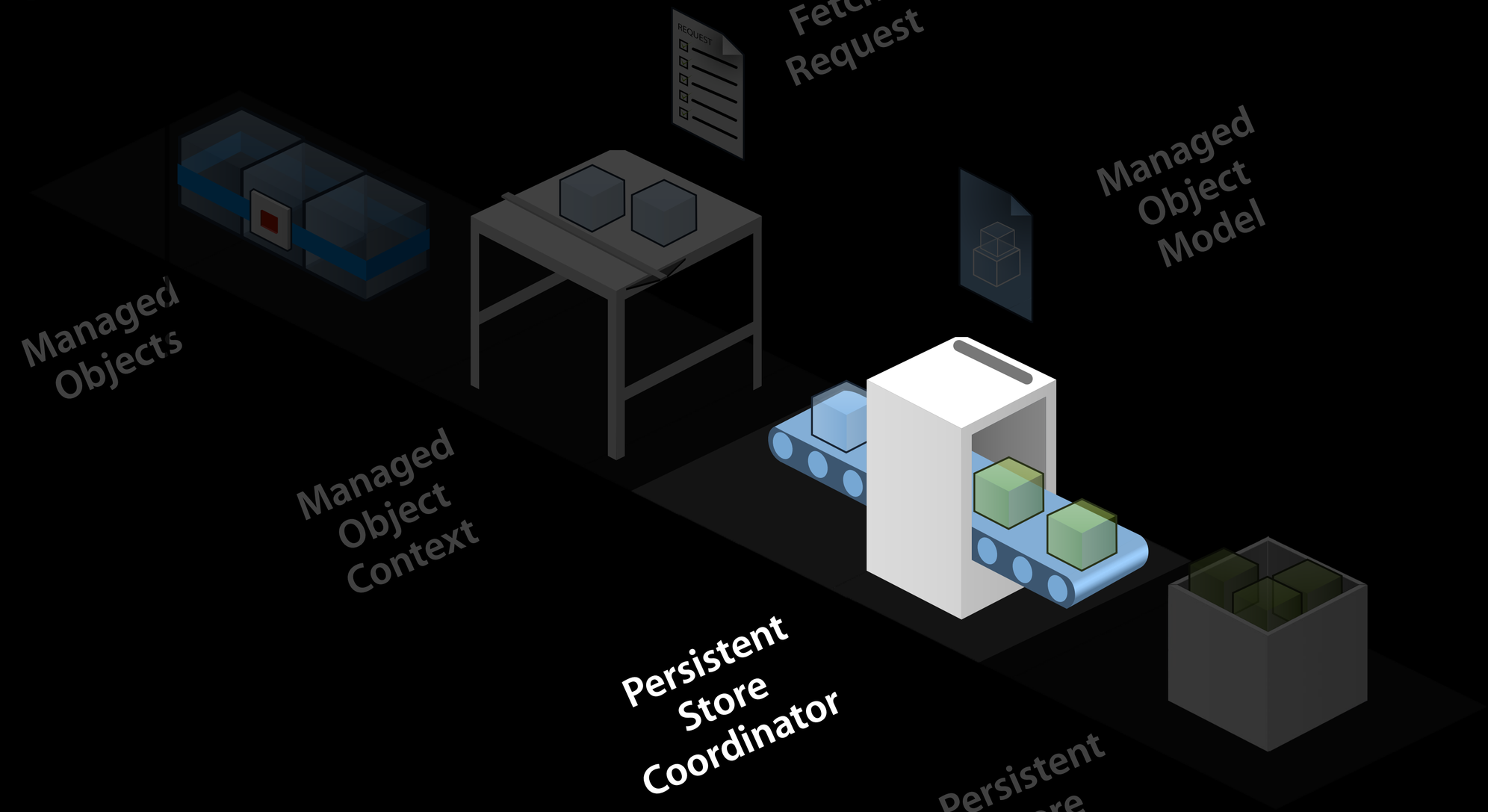

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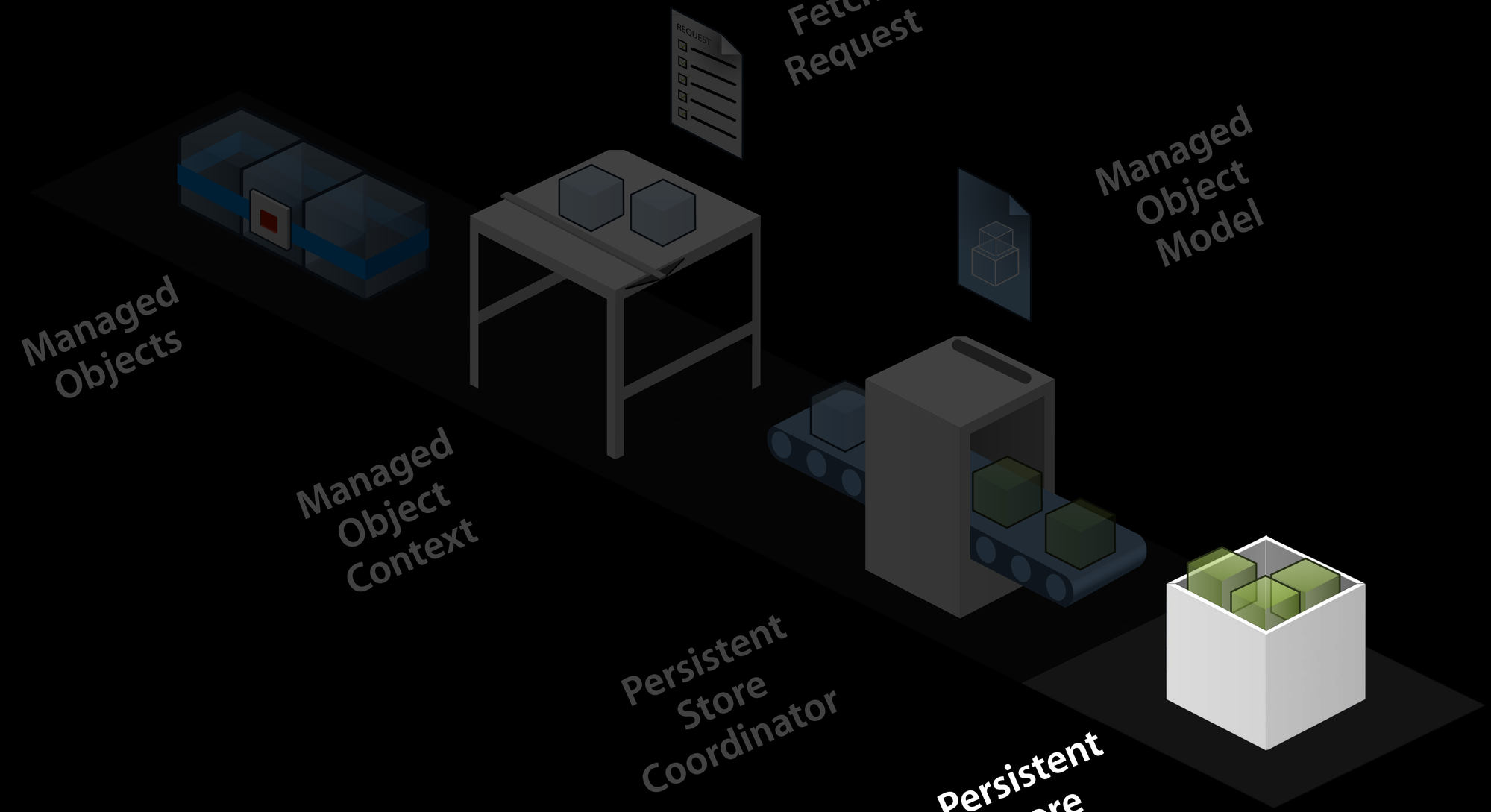

Core Data: The Architecture

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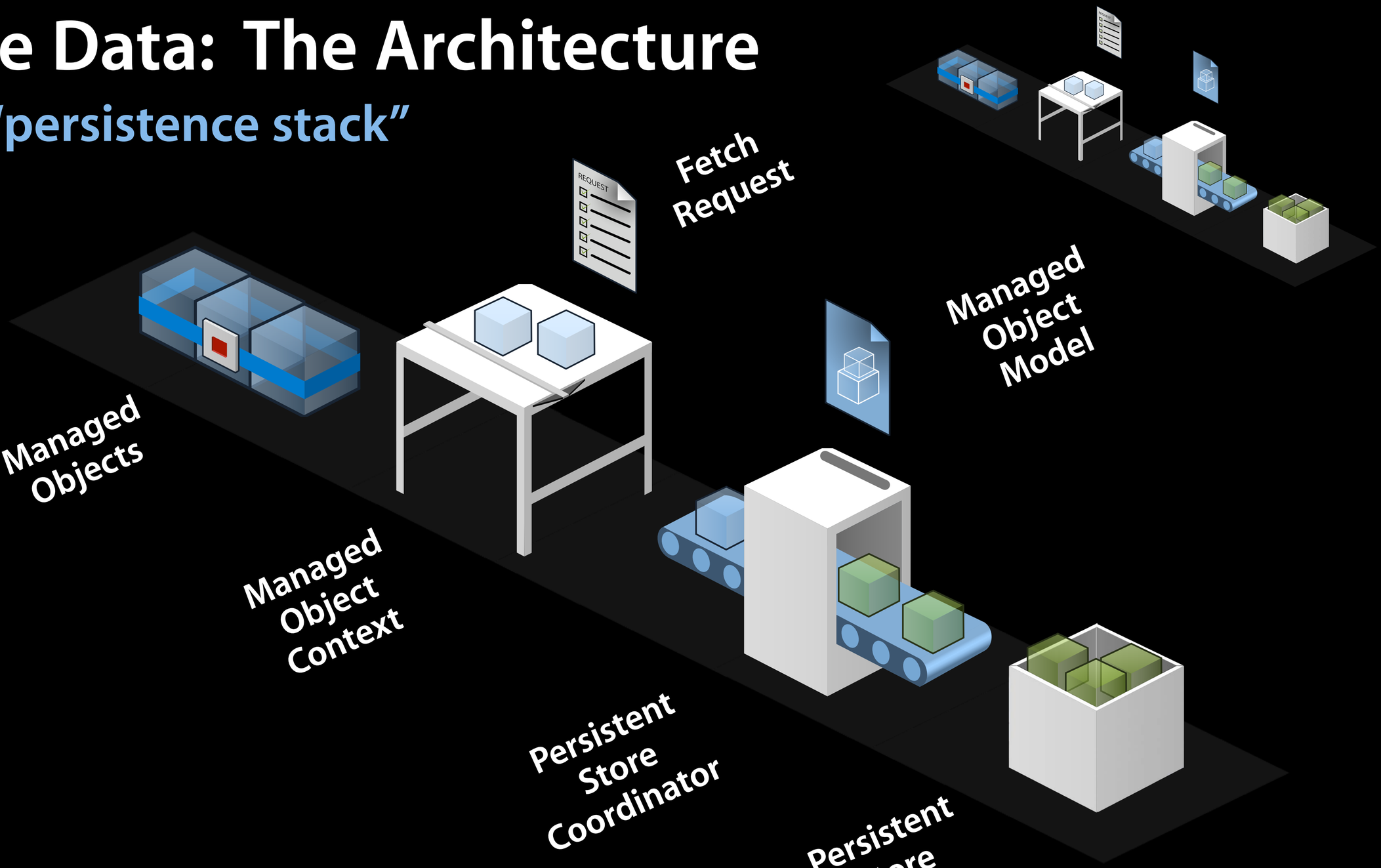
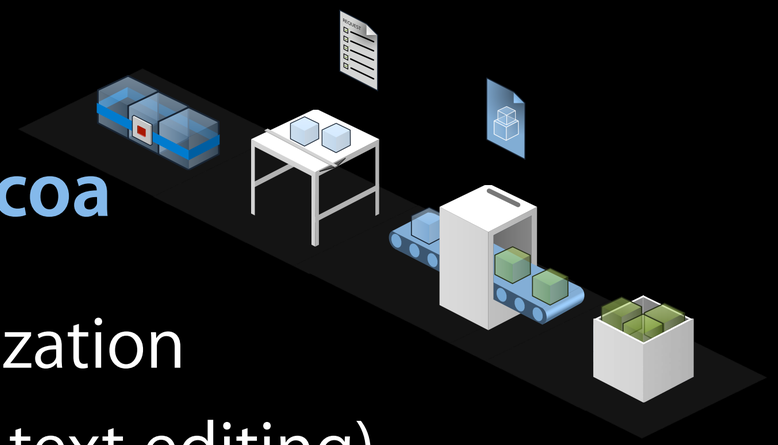


What Does Core Data Do?

Object management and persistency for Cocoa



- Integration with Cocoa bindings for UI synchronization
- Built-in management of undo and redo (beyond text editing)
- Automatic validation of property values
- Grouping, filtering, and organizing data
- Change propagation, including maintaining consistency of relationships
- Automatic support for storing objects in external data repositories
- Several store options (SQL, XML, binary)

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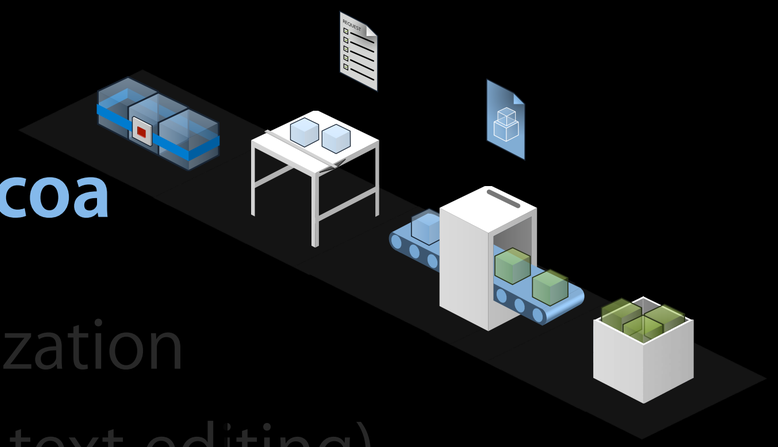

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- Built-in management of undo and redo (beyond text editing)
- Automatic validation of property values
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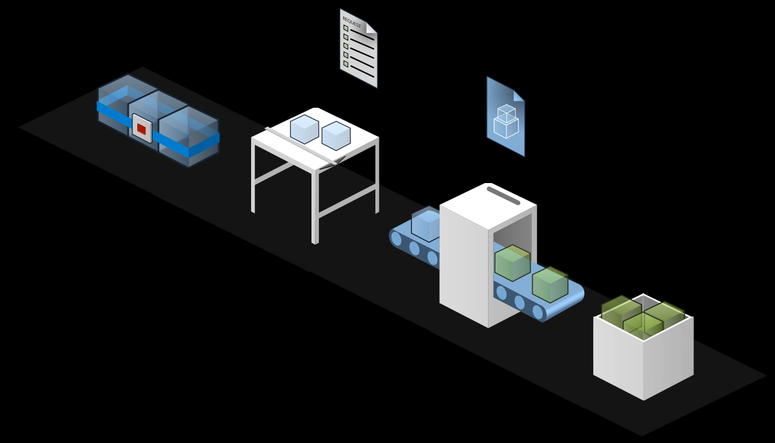
- Several store options (SQL, XML, binary)

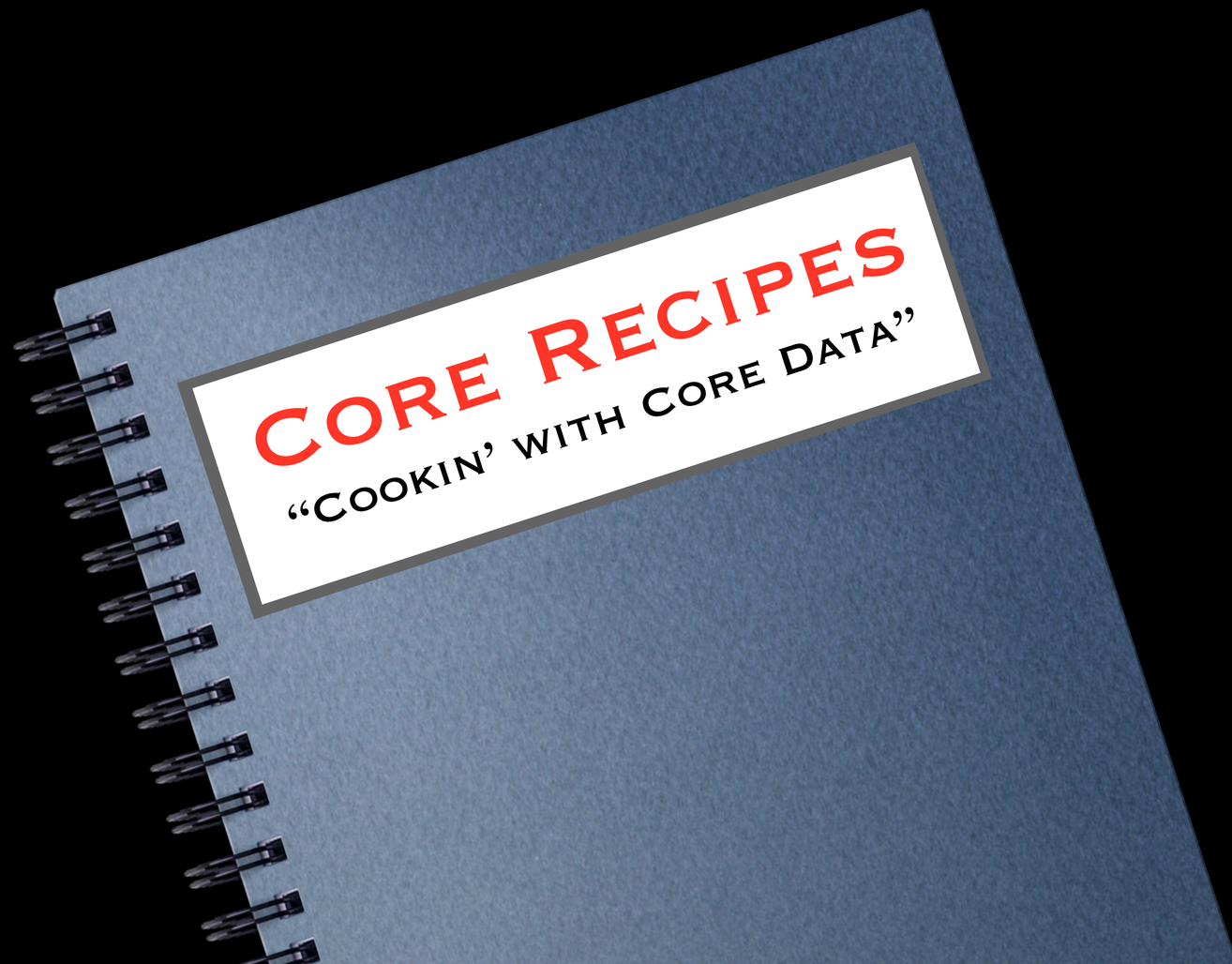
Use a much as you need

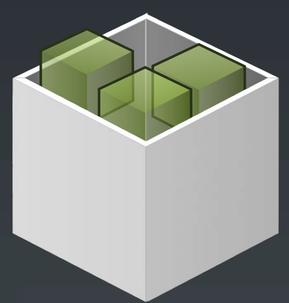
WWDC Sample Code

“CoreRecipes”



- Hands-on samples (for tomorrow’s session)
  - Command-line and GUI applications
- CoreRecipes application
  - Core Data essentials
  - Cocoa bindings
  - Spotlight integration
  - Automator action
- Data migration sample





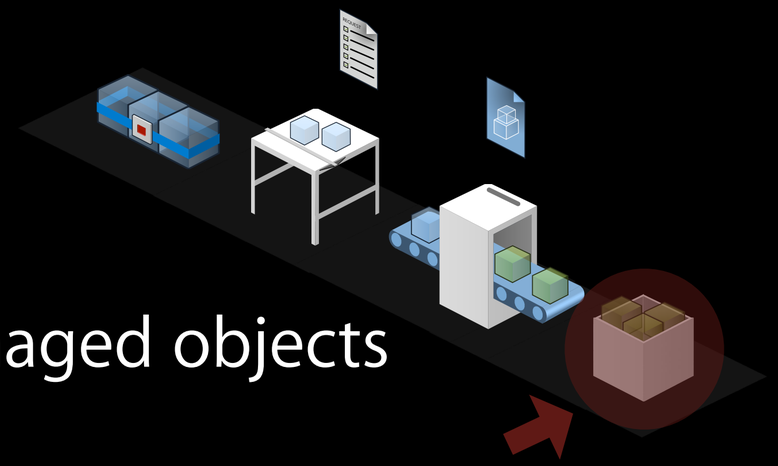
The Persistent Store

Where your data comes and goes

http://developer.apple.com/wwdc2005/

The Persistent Store

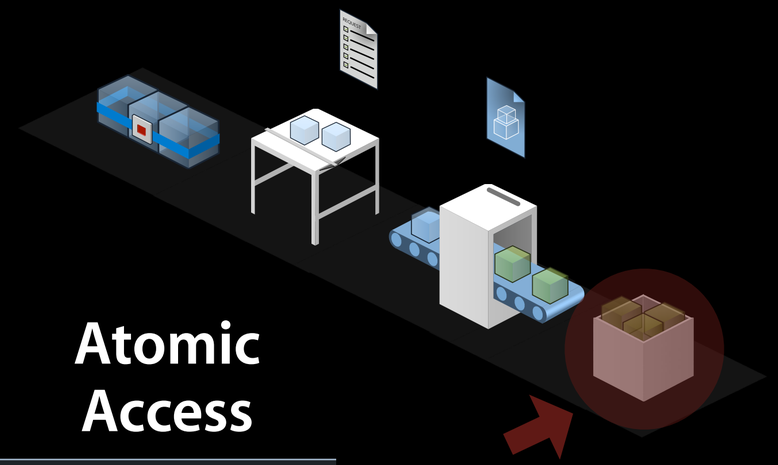
Where your data comes and goes



- Logically, a file or collection of files in which managed objects may be stored
- Transparent to the application and developer
  - Each store has a Universally Unique Identifier (UUID) and type
  - Currently, no API to work with stores directly
  - Use the persistent store coordinator to interact

Persistent Storage Options

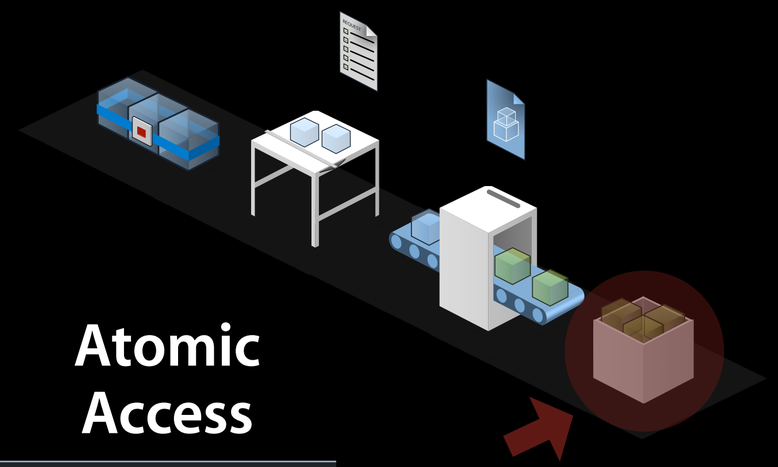
Types and benefits



	Scalability	Speed	Human Readable	Atomic Access
XML		Good	✓	✓
Binary		Better		✓
SQLite	✓	Best		

The In-Memory Store

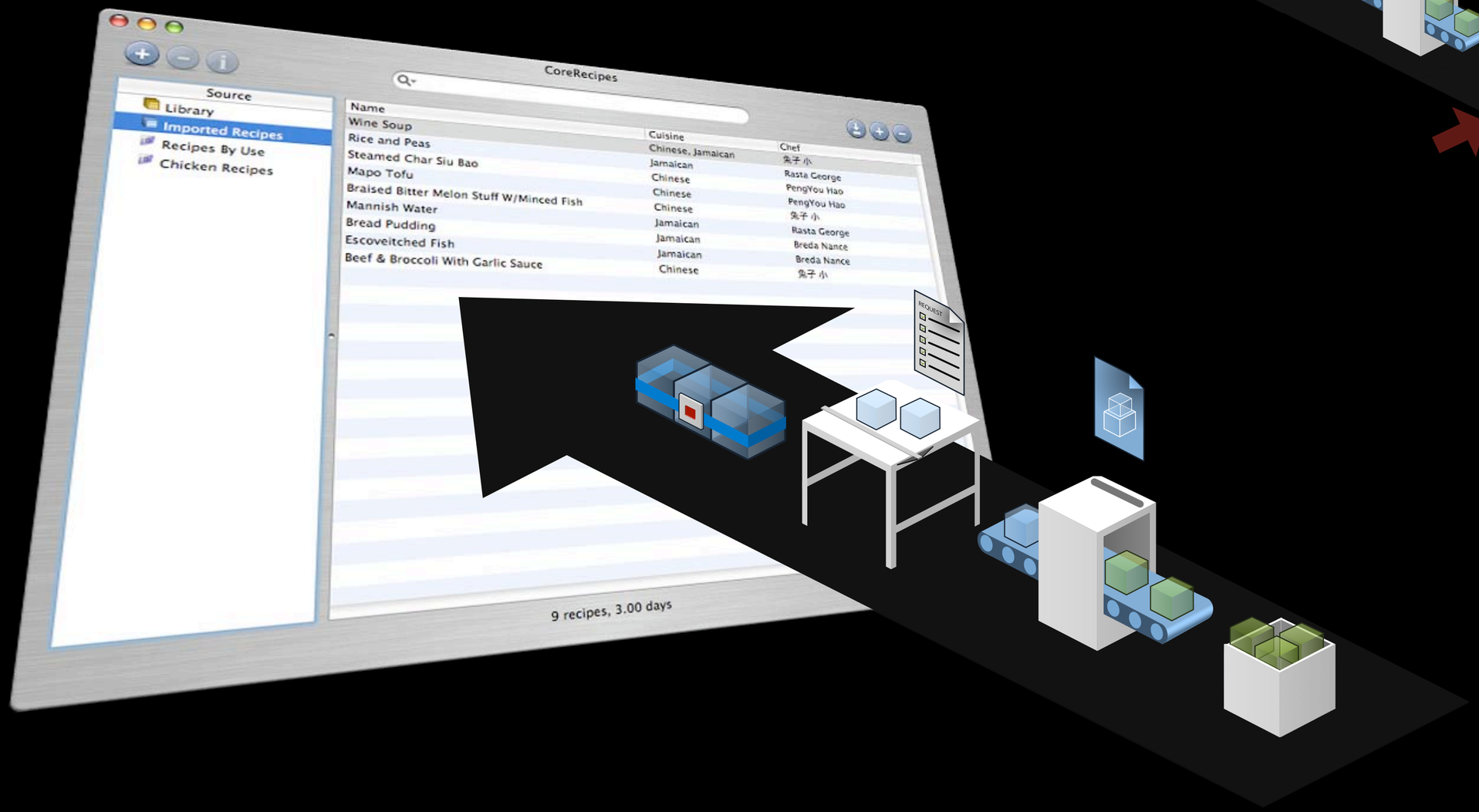
Use with existing files or transient data



	Scalability	Speed	Human Readable	Atomic Access
XML		Good	✓	✓
Binary		Better		✓
SQLite	✓	Best		
In-Memory				

How Many Stores to Use?

Some applications use one…



How Many Stores to Use?

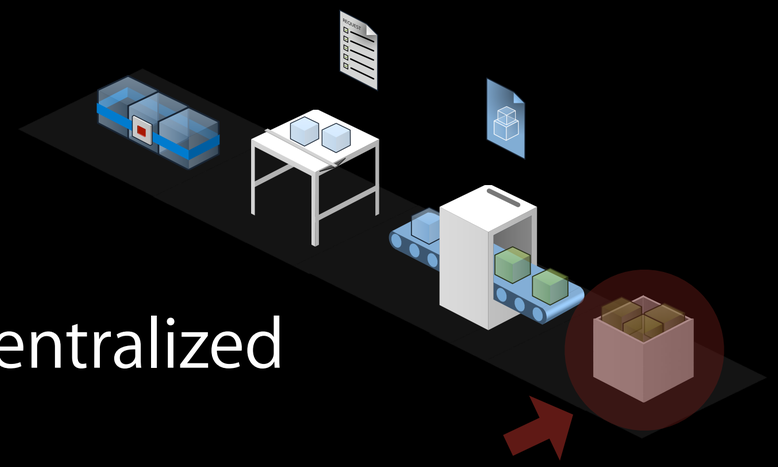
Some applications use many, *collaborative*…

How Many Stores to Use?

Some applications use *separate* documents…

How Many Stores Should I Use?

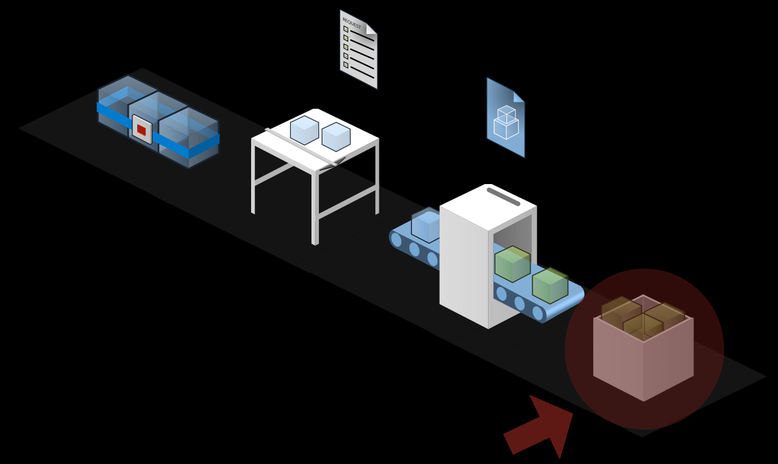
It depends on what you are designing…



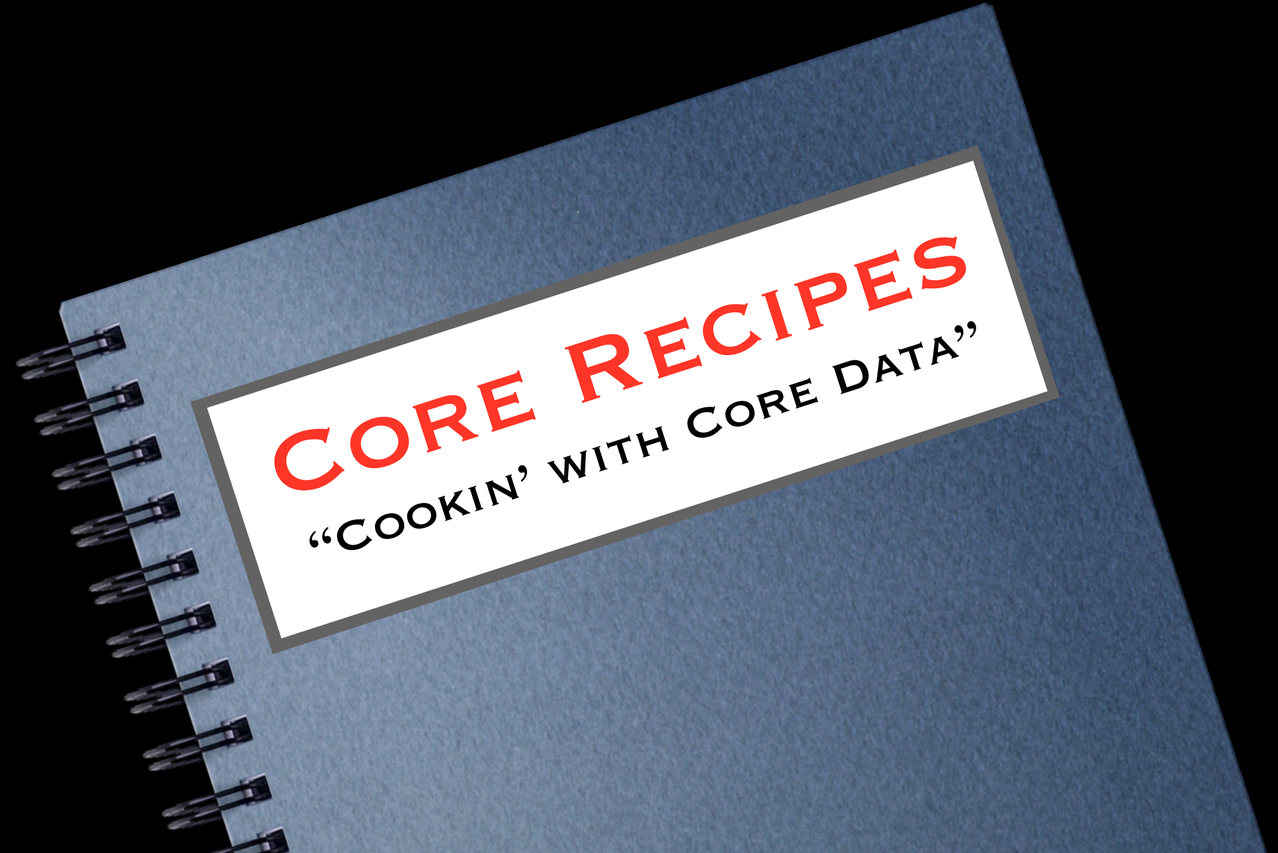
- Single stores for applications where the data is centralized and the information is inter-related
- Multiple stores for projects that might need to "share" data
  - Be careful about cross-store dependencies
- Document-based stores for data that is completely encapsulated

Core Recipes App

A tough decision



- Recipes as separate documents?
- All recipes in a single store?
- Implemented as a multiple store application



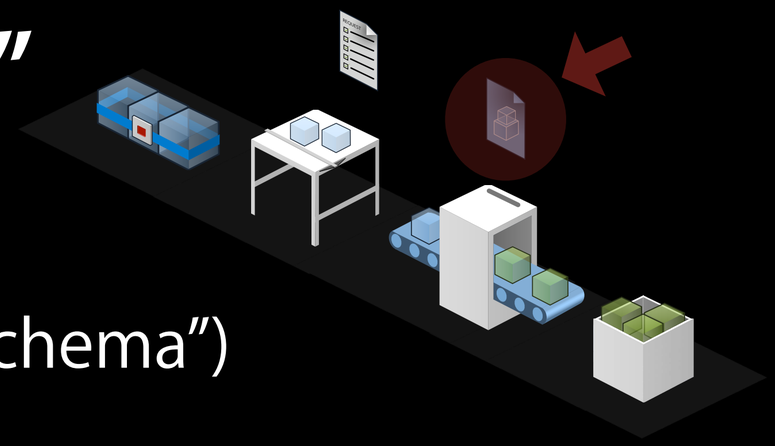
The Managed Object Model

Your data blueprint

http://developer.apple.com/wwdc2005/

What Do You Mean, "Modeling?"

Creating a blueprint for your data

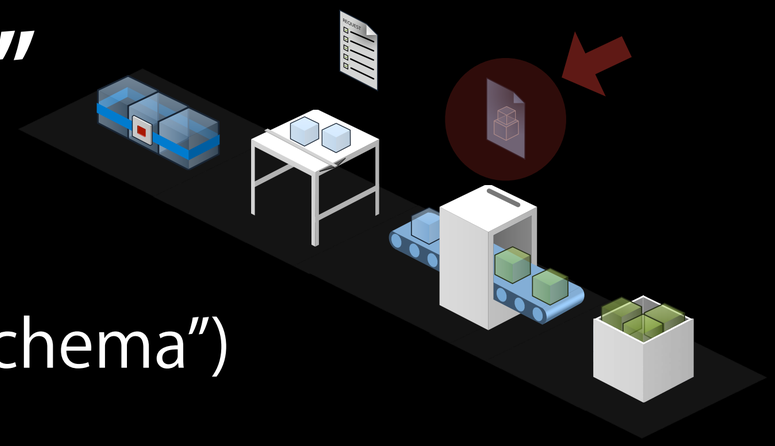


- A managed object model is a high-level view ("schema") of the data for your application

Entity	Classification of Object Runtime representation
Property	Characteristics of an entity Attributes or relationships

What Do You Mean, "Modeling?"

Creating a blueprint for your data

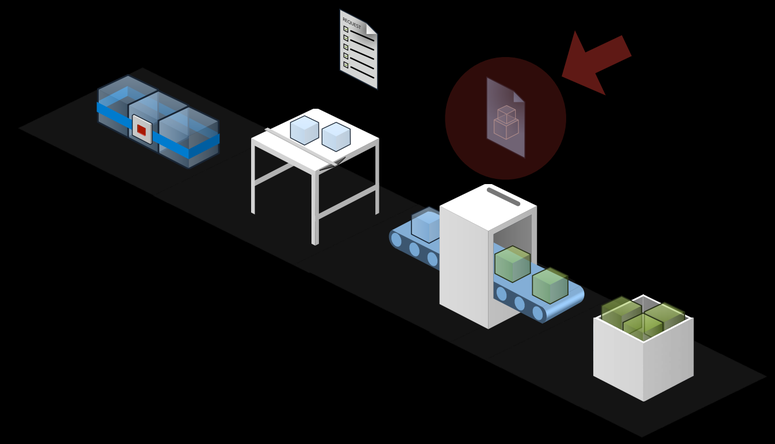


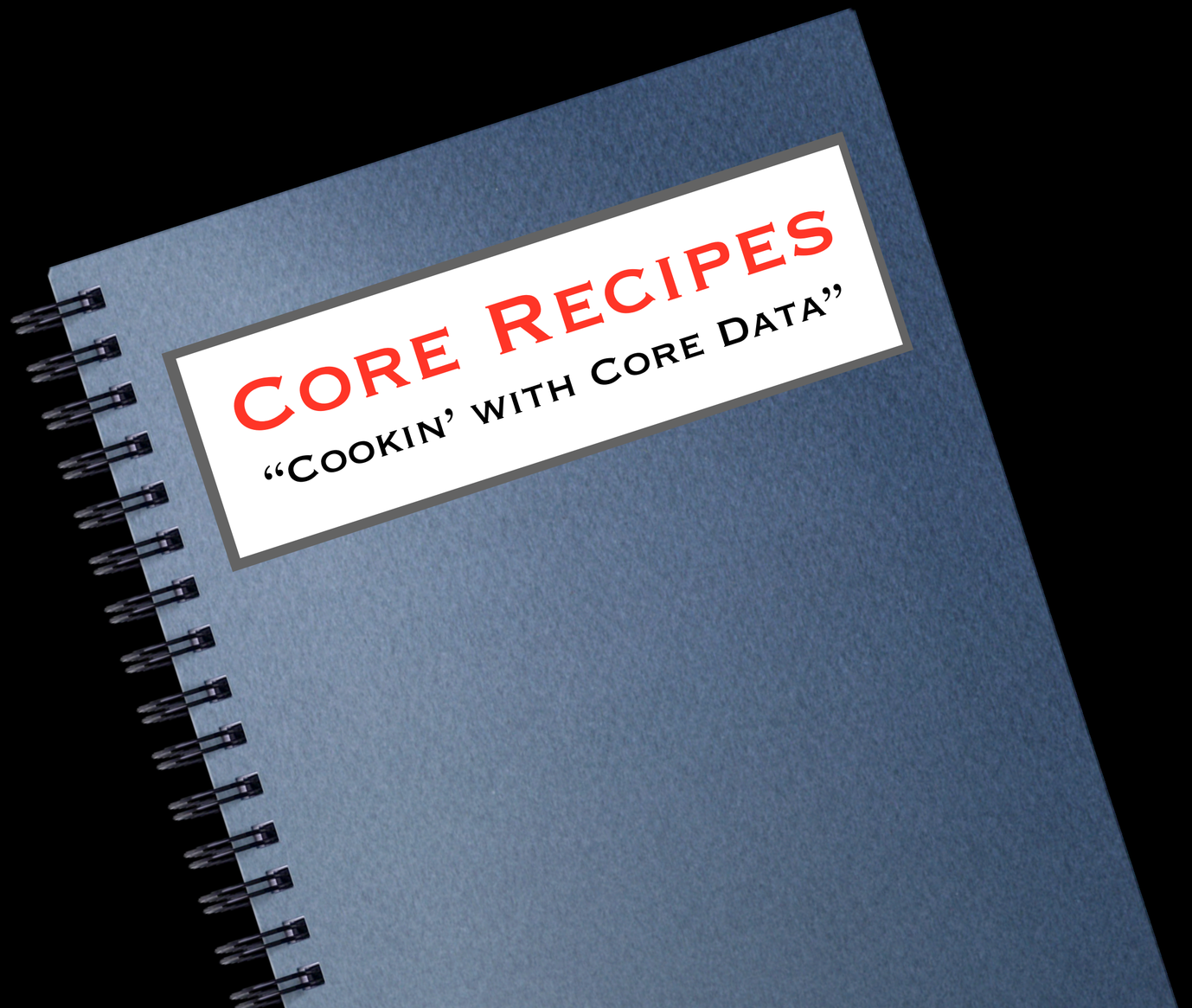
- A managed object model is a high-level view ("schema") of the data for your application

Entity	Classification of Object Runtime representation
Attribute	Simple instance variable
Relationship	Managed references to other entities Singular ("to-one") or multiple ("to-many")

Core Recipes App

An example of decomposing data…





Core Recipes App

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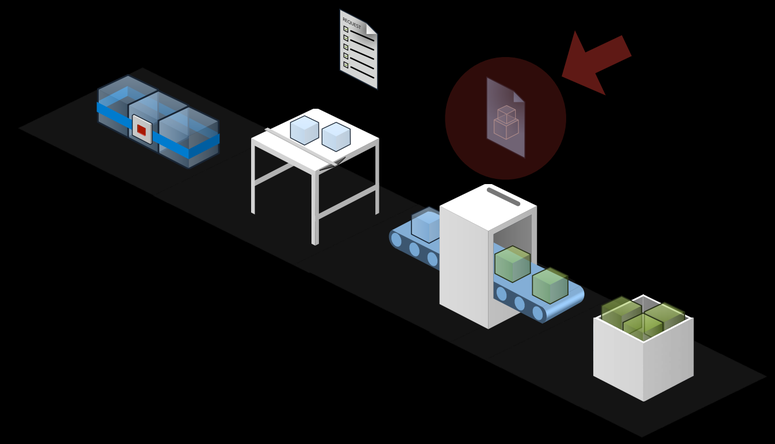

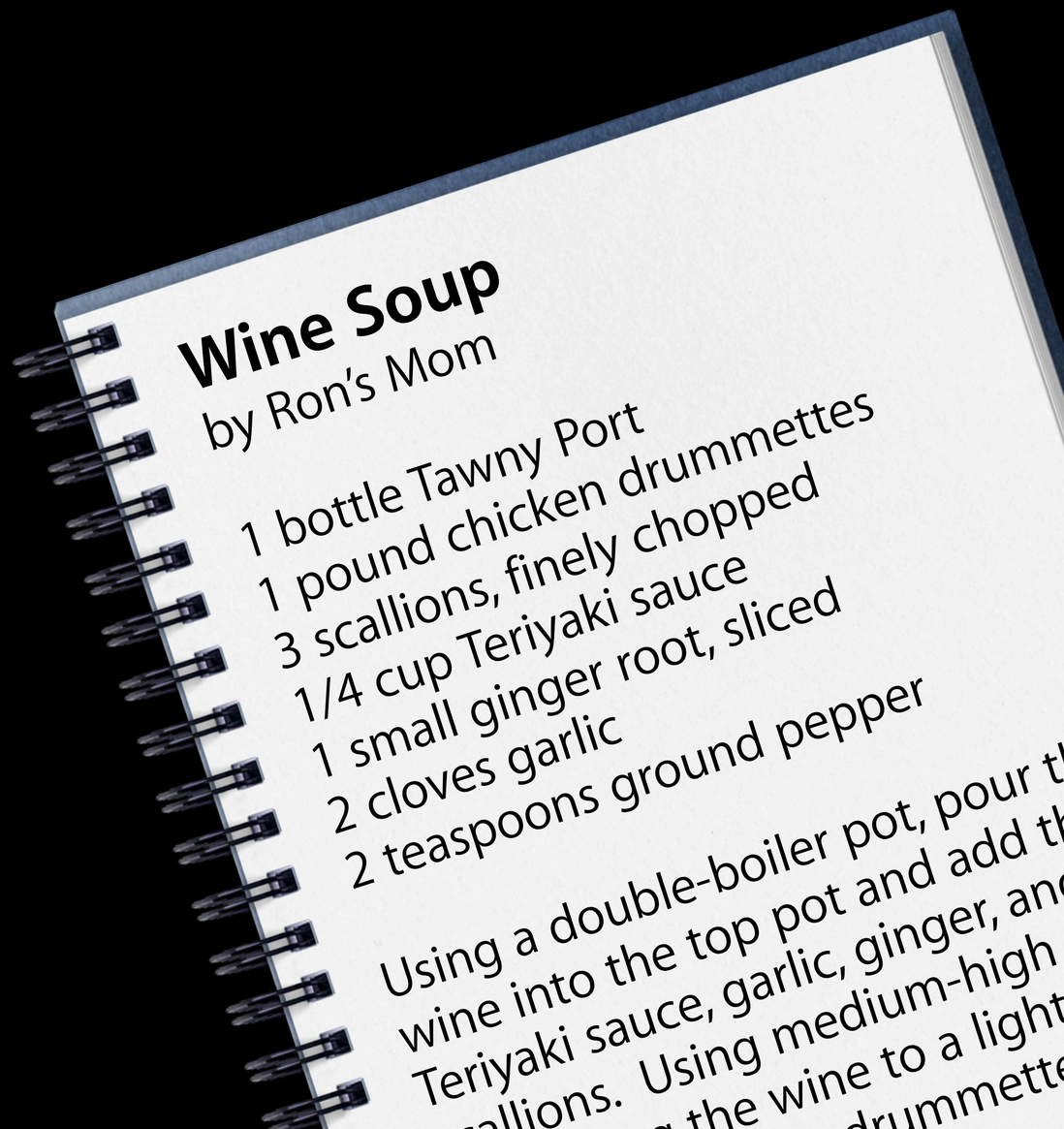

Core Recipes App

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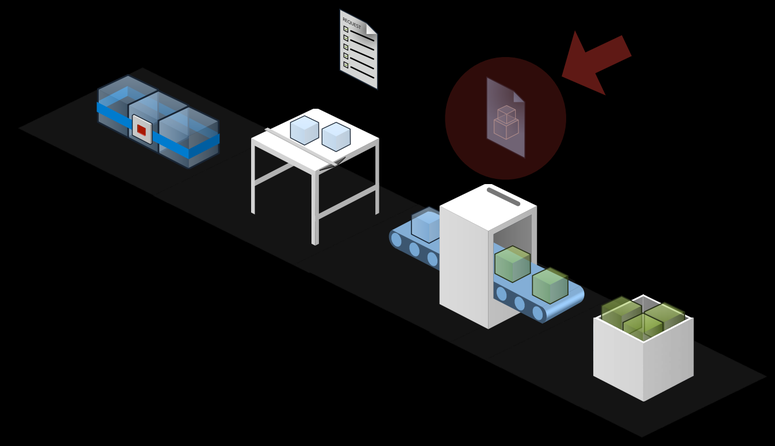

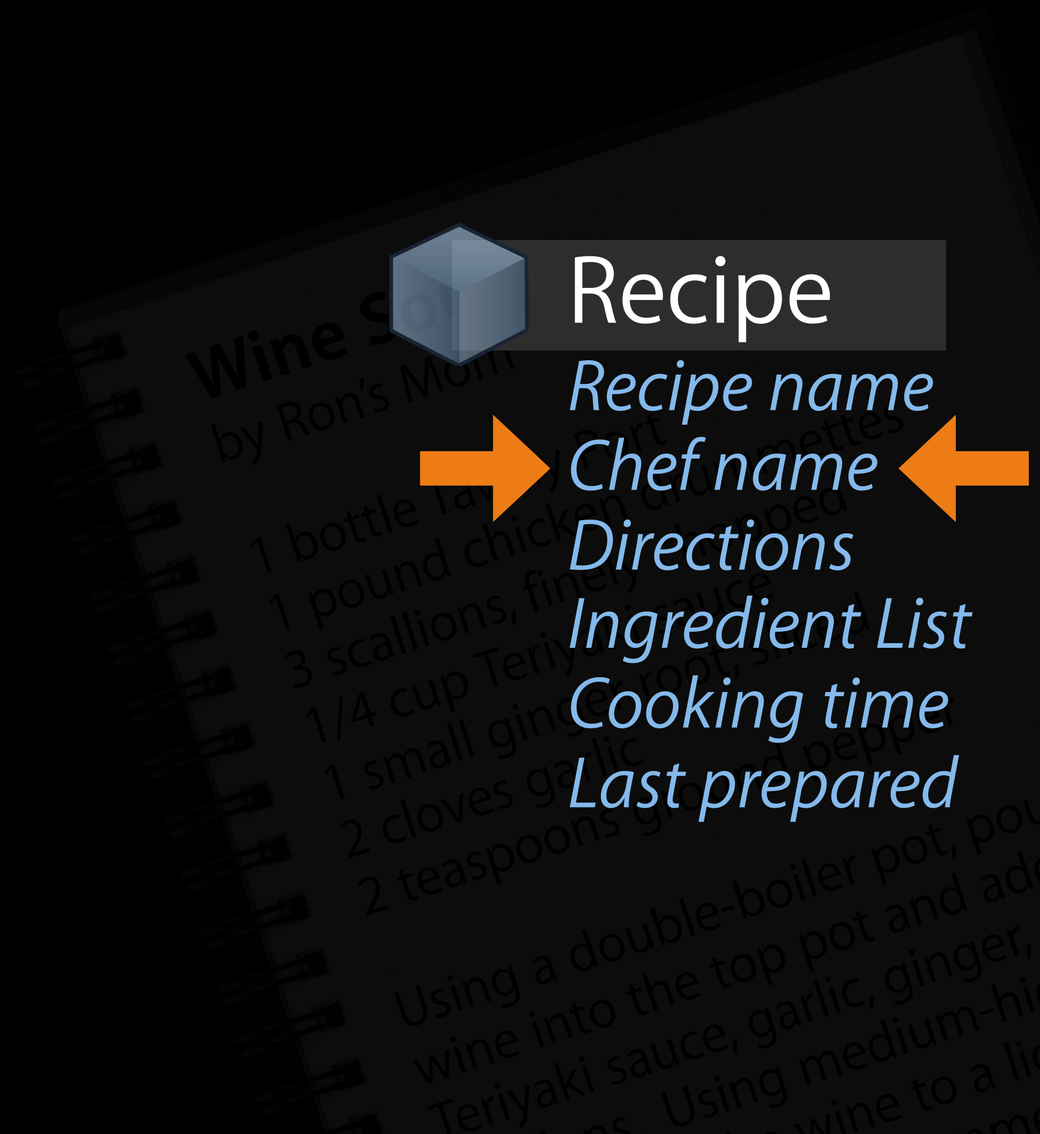

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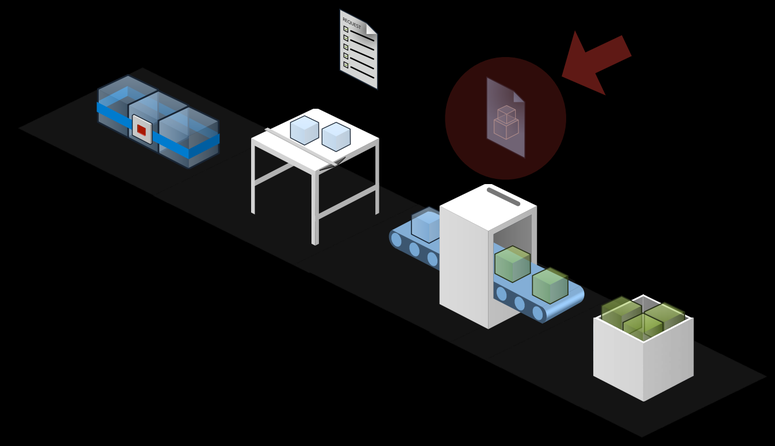
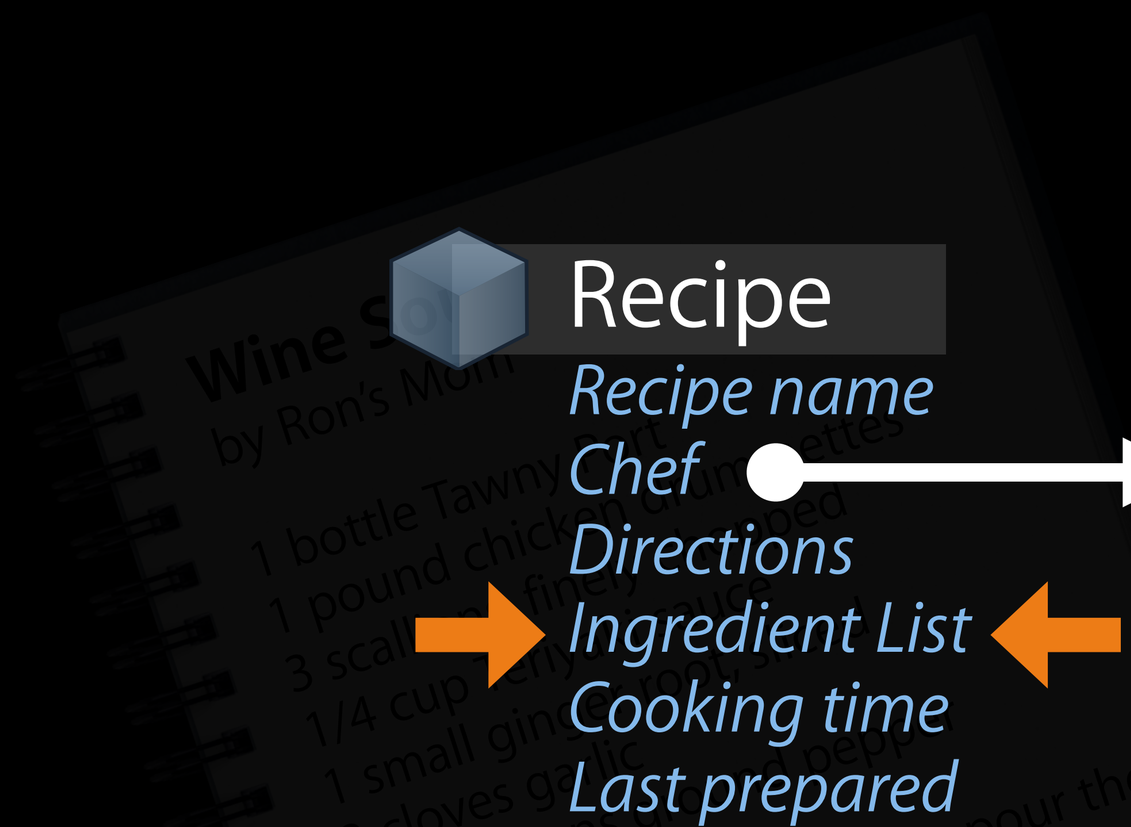


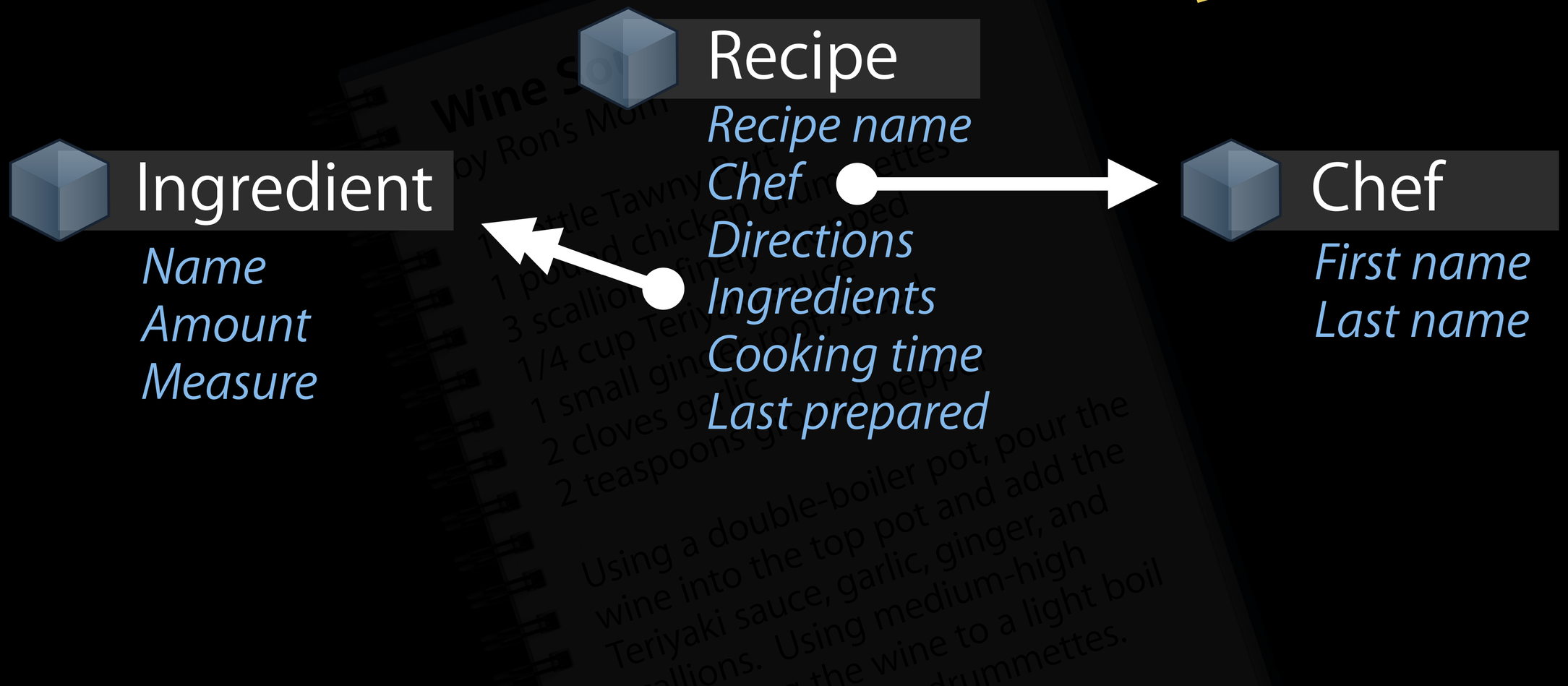


Core Recipes App

An example of decomposing data…

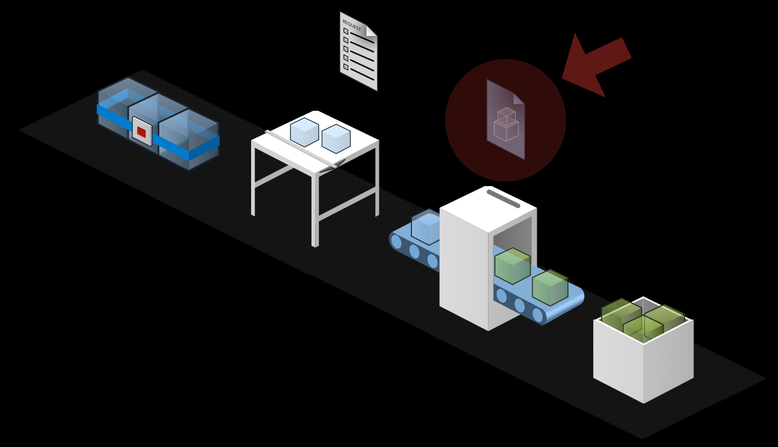
API Reminder

```
to-many relationships
always return sets, not
arrays
```



What Happens at Runtime?

The model is used as a blueprint…



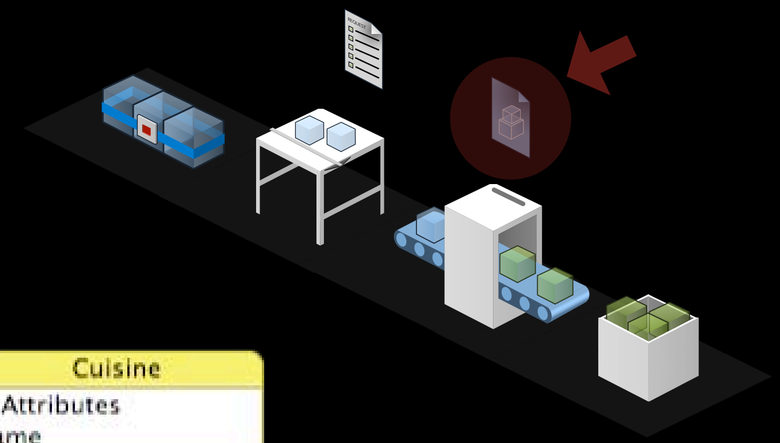
Recipe

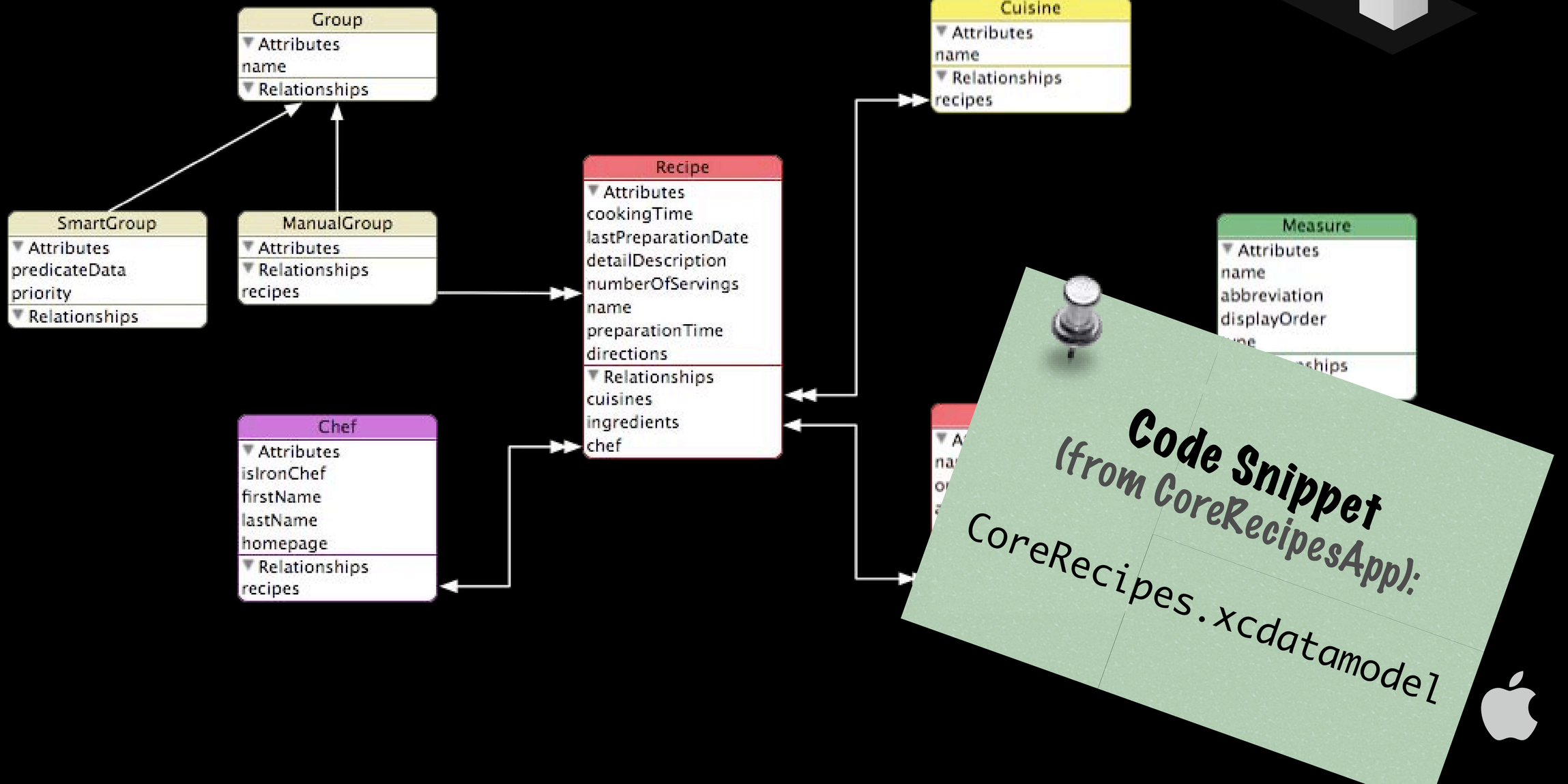
Recipe name
Chef
Directions
Ingredients
Cooking time
Last prepared

```
<Recipe: 0x451d8c0>
 (entity: Recipe; id: 0x38c130
<x-coredata://CBBE4927-854E-4277-88B0-A4A799582B
    recipeName = "Wine Soup";
    chef = 0x38b170 <x-coredata://CBBE4927-854E-4277
    directions = "Using a double-boiler pot, pour the wi
    ingredients = "<relationship fault: 0x451e000 'ingred
    cookingTime = 0;
    lastPrepared = 2005-05-26 02:07:16 -0700;
})
```

Core Recipes App

In the end, it might look like…





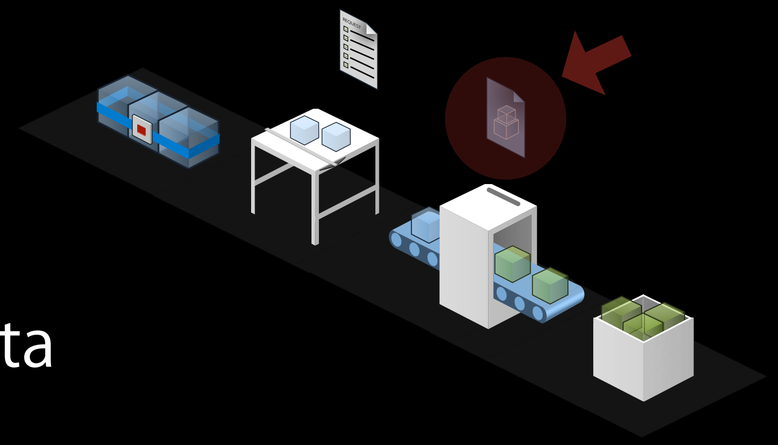
What Else Can My Model Do?

Quite a bit, actually…

- Define default attribute values
- Set-up validation rules
- Set-up deletion rules (for relationships)
- Create query templates
- Customization (using userInfo dictionaries)

How Important Is the Model?

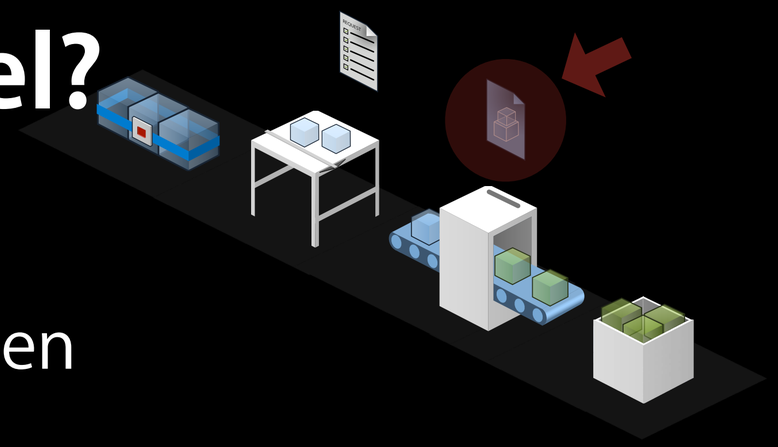
Absolutely critical



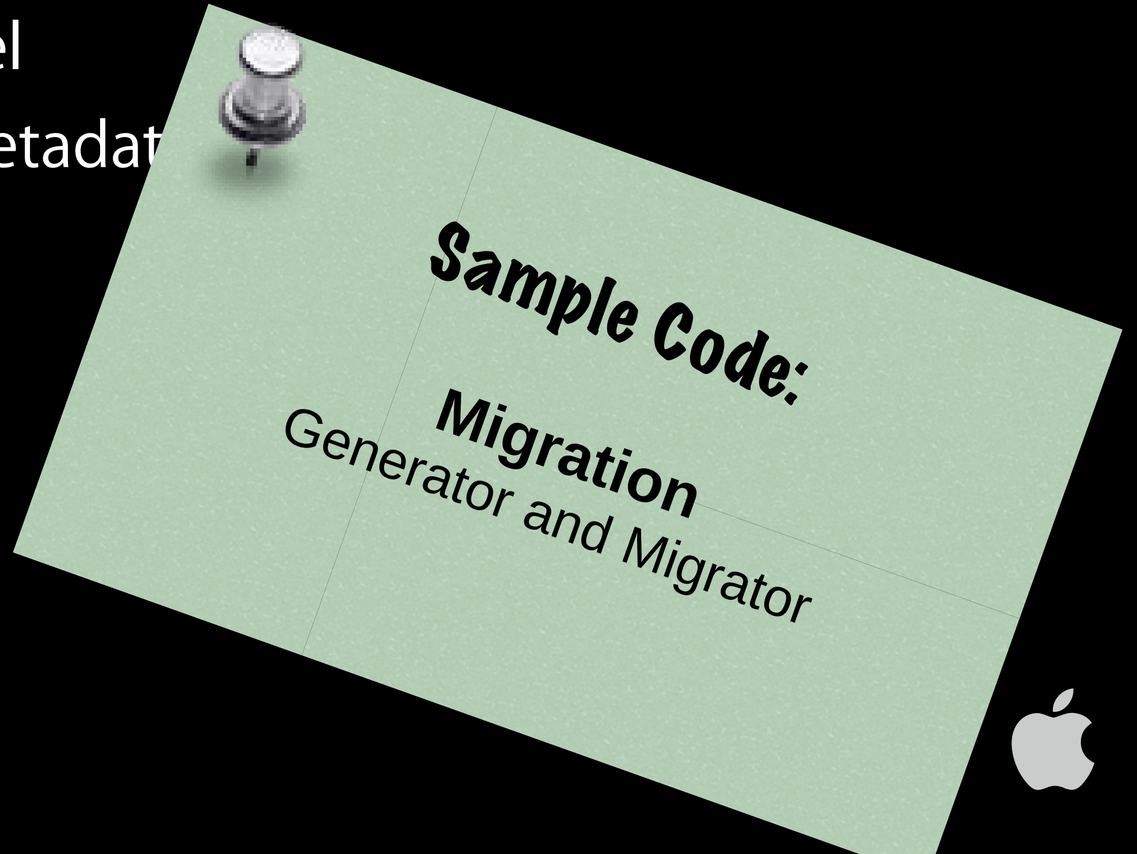
- Models are "contracts" between you and Core Data
  - Defines guidelines for data interaction
  - Outlines policies to maintain integrity
- Design with function **and** performance in mind
  - Consider both fine and coarse-grained objects
- The more complicated the model, the greater the value-add of Core Data

What About Changing My Model?

The question of versioning



- Making changes to your model after data has been saved in a persistent store is not supported
  - This is a general issue with “versioning”
- Some things to think about
  - Storing a version number with the model
  - Saving the model version in the store metadat

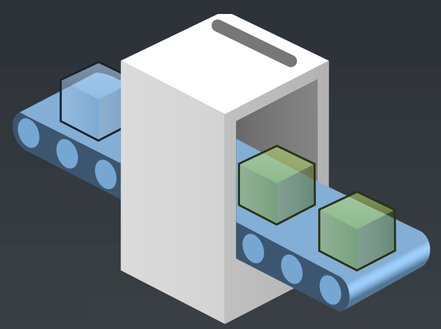


Demo

Creating a managed object model in Xcode

Adam Swift
Engineer, Core Data

http://developer.apple.com/wwdc2005/



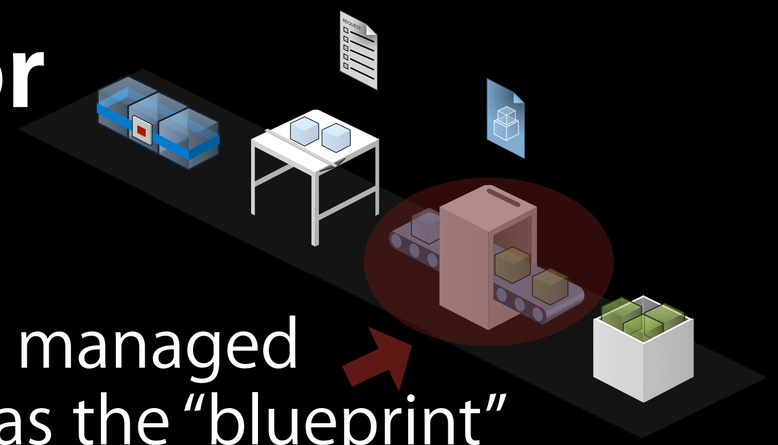
The Persistent Store Coordinator

The framework's middleman

http://developer.apple.com/wwdc2005/

The Persistent Store Coordinator

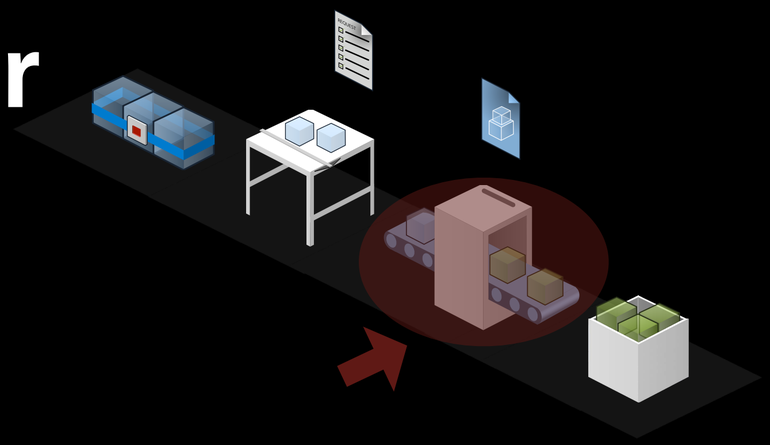
The framework's middleman

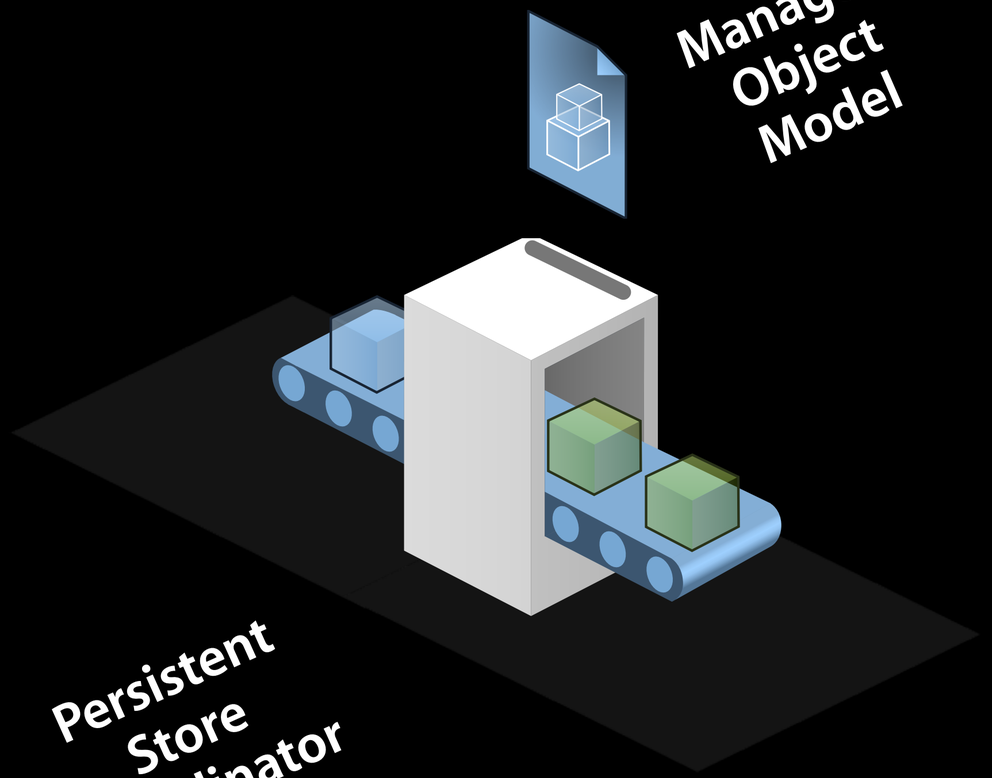


- Coordinates moving objects between stores and managed object contexts, using a managed object model as the "blueprint"
- Referred to commonly as the "PSC"
- Synchronizes access to persistent stores
- Unified representation for multiple stores
  - Striping, no mirroring

The Persistent Store Coordinator

The facade in front of stores





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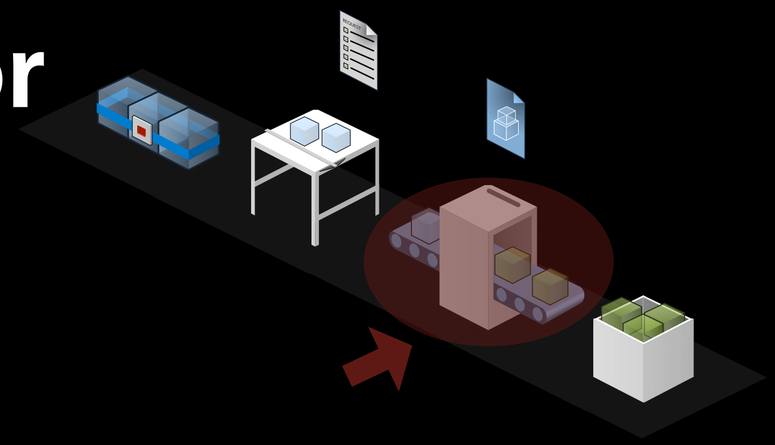

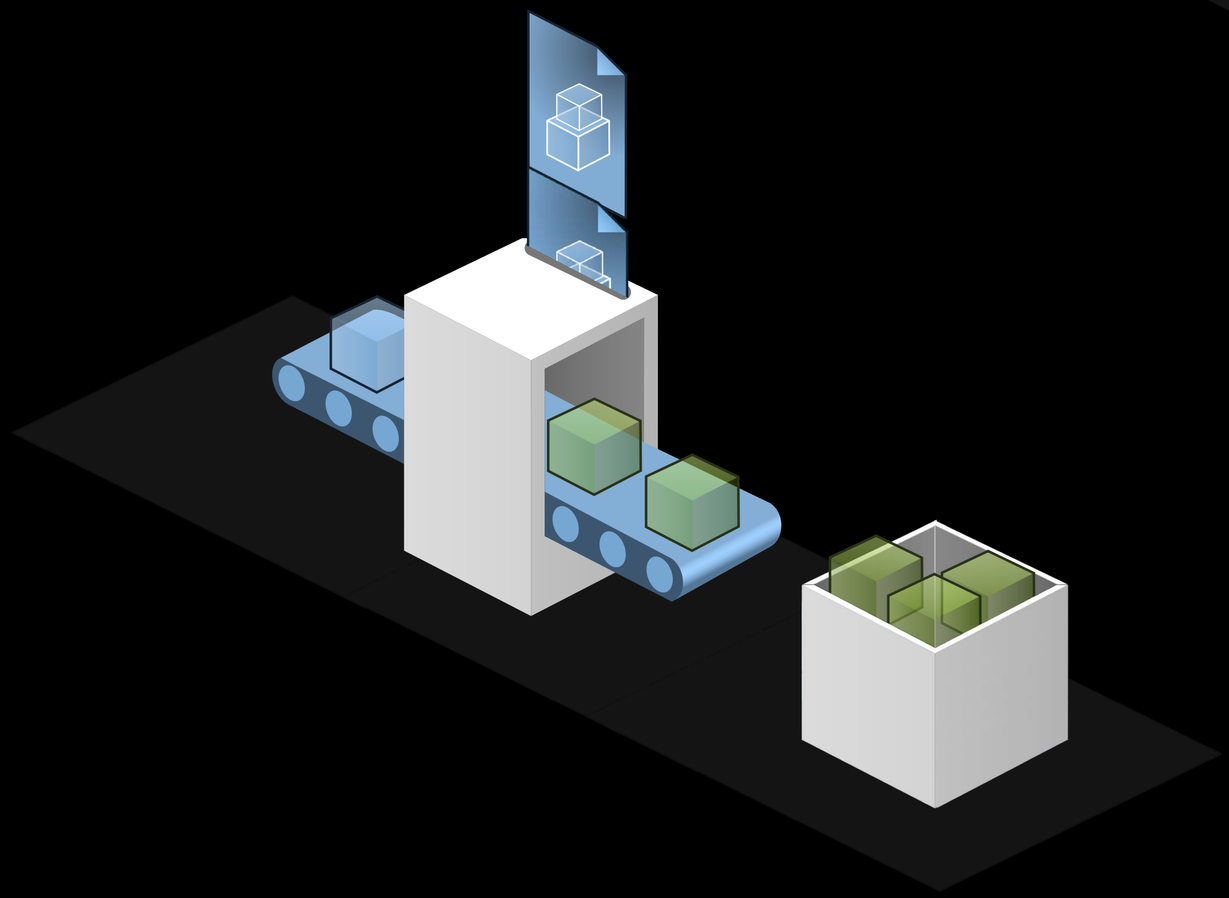

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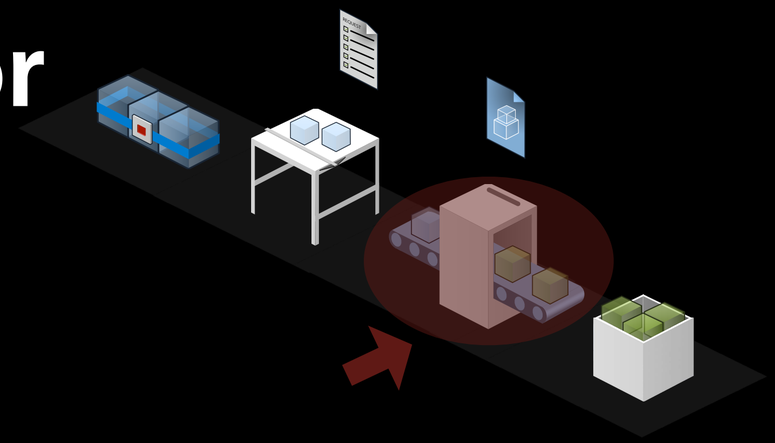
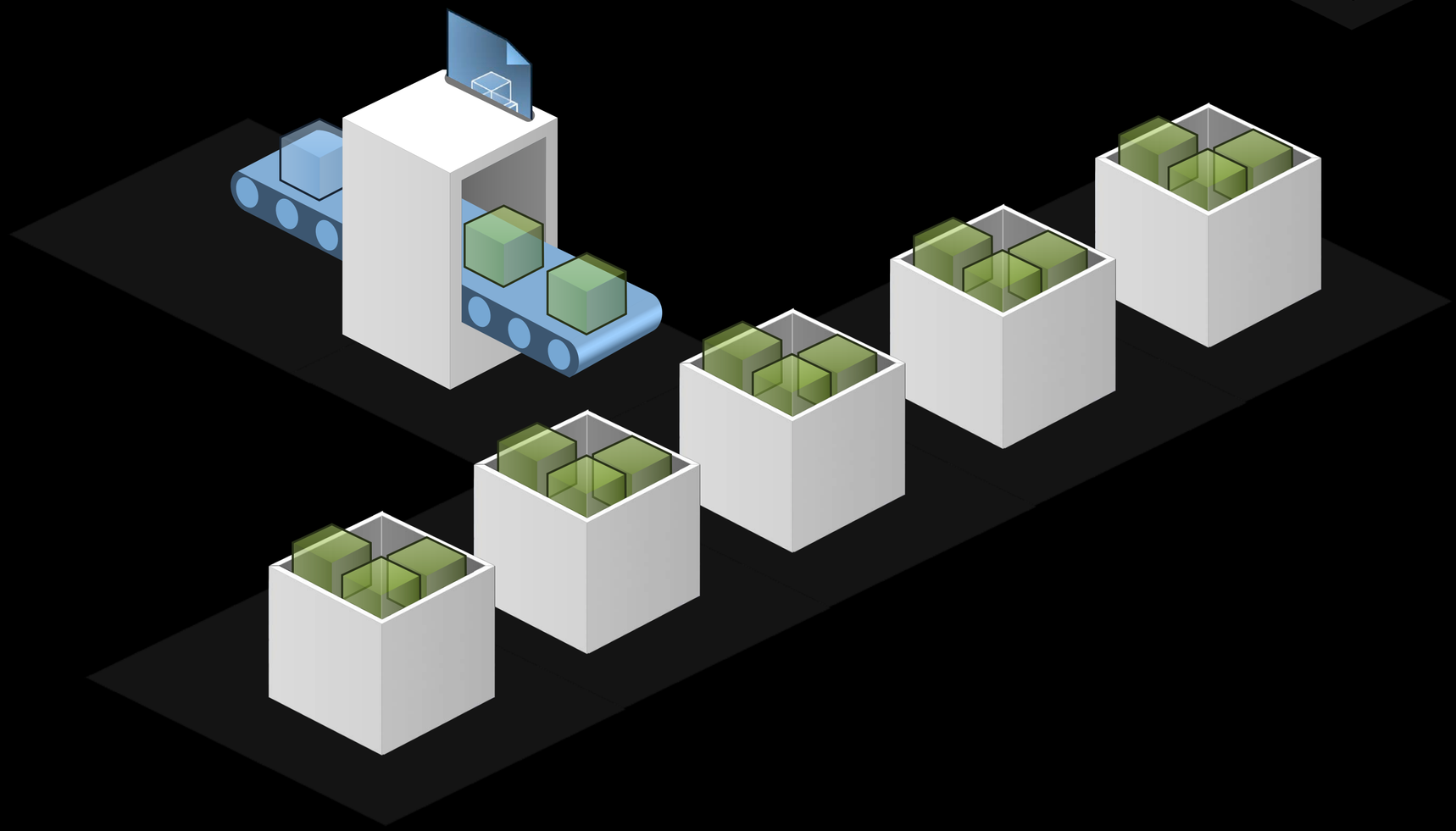
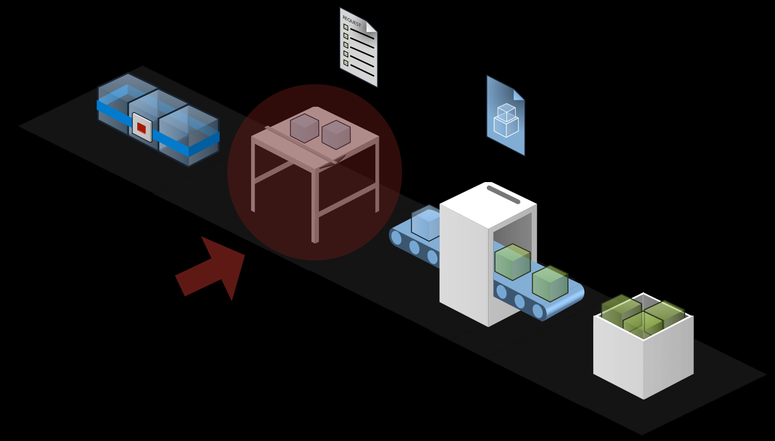
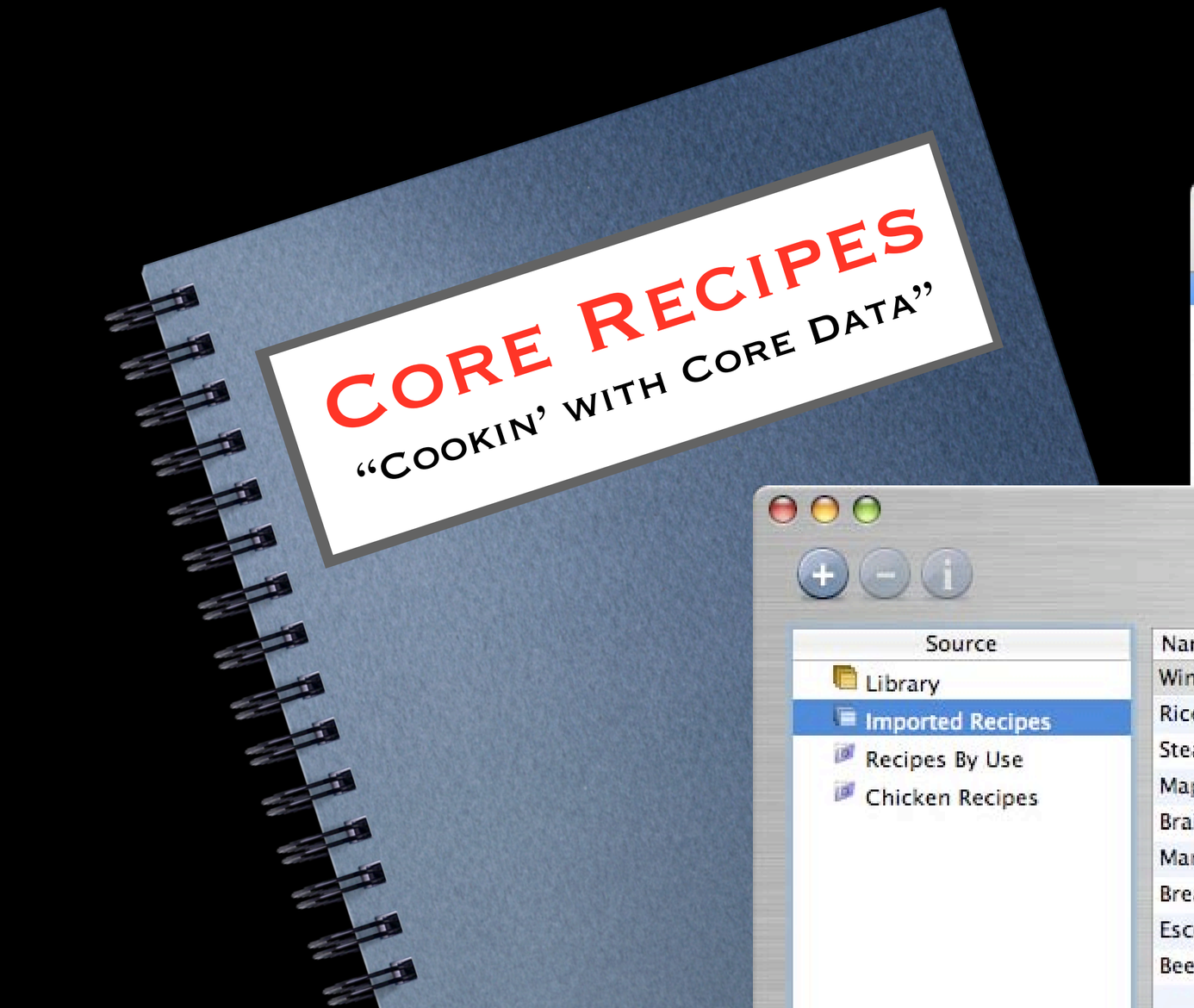


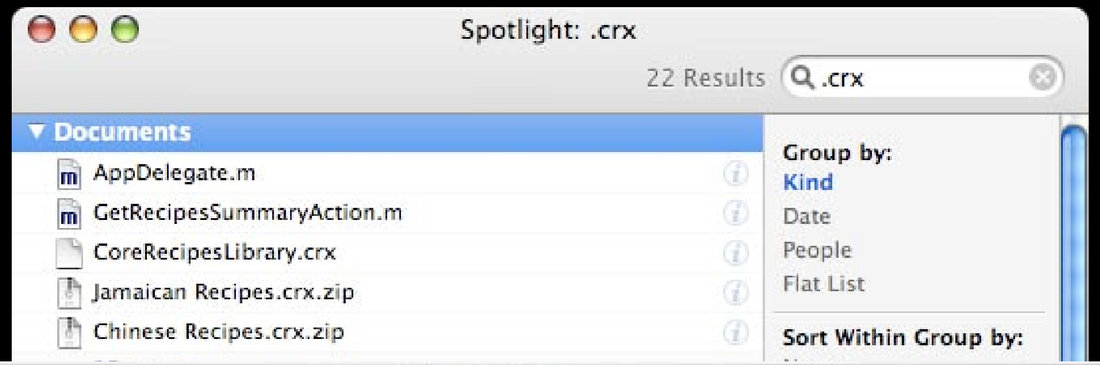


Core Recipes App

Uses Spotlight to find and load stores







What About "Metadata"?

How Core Data and Spotlight relate…

- Spotlight and Core Data are complementary:
  - Core Data is about the "inner workings" of your a
  - Spotlight is about an "outside view" of your conte
- The PSC provides simple API to read and write m tores

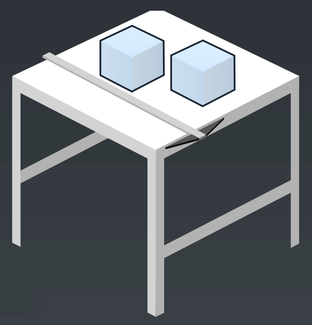
API Reminder:

```
NSPersistentStoreCoordinator
metadataForPersistentStore:
```

Sample Target and Code:

CoreRecipesApp

CoreRecipesSpotlightImporter



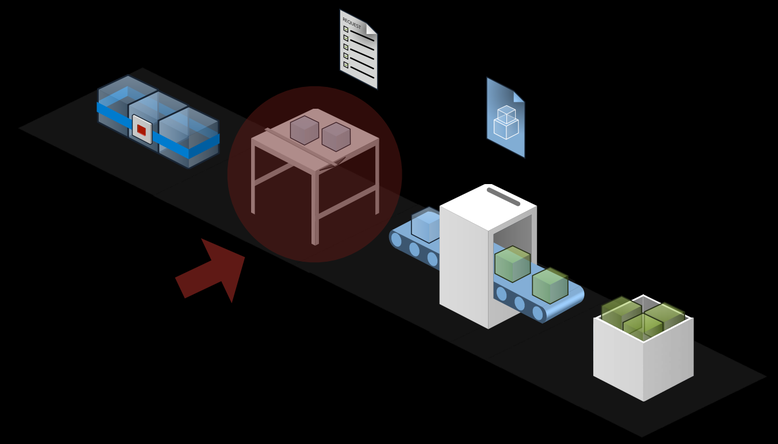
The Managed Object Context

The drafting-table for your data

http://developer.apple.com/wwdc2005/

The Managed Object Context

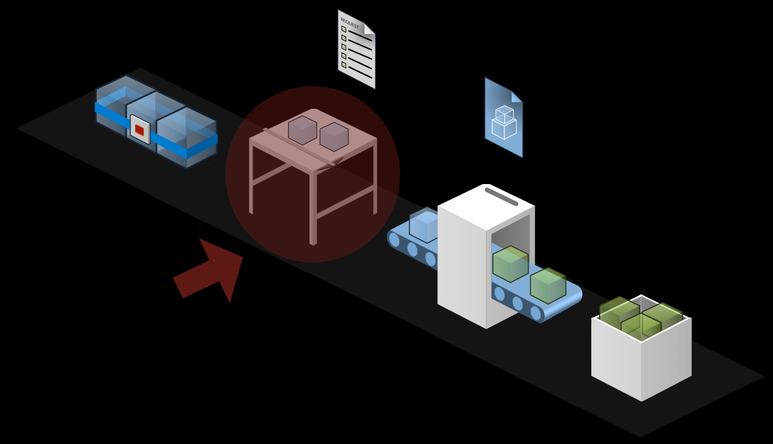
The drafting-table for your data

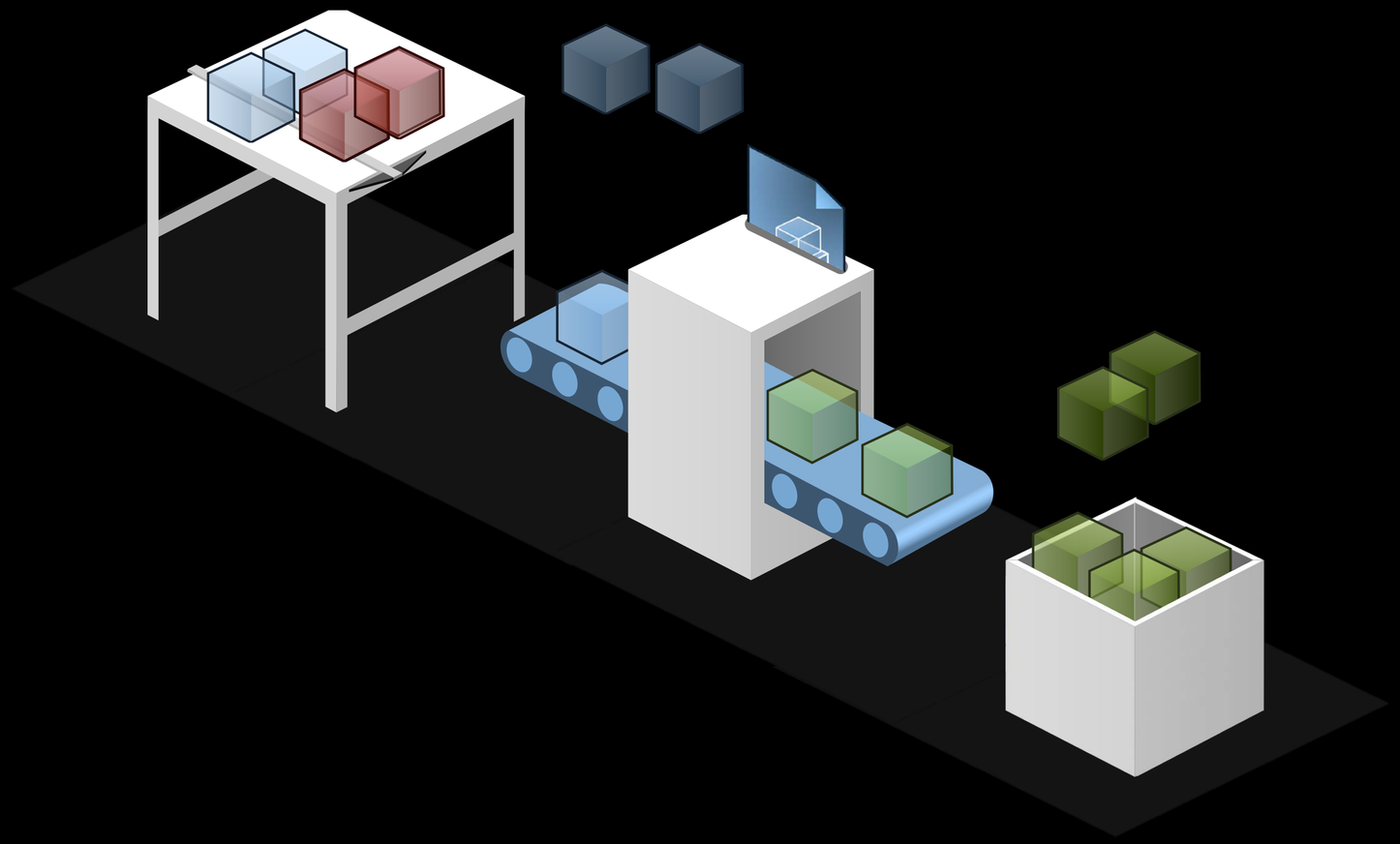


- Primary "workspace" of Core Data framework
  - Retrieve objects from stores
  - Making, saving, and reverting changes
  - Handling notifications of Core Data events
- Consider it a "scratchpad" for working with your data
  - Undo or revert changes at any time
- Referred to commonly as the "**MOC**"

The Managed Object Context

The drafting-table for your data





The Managed Object Context

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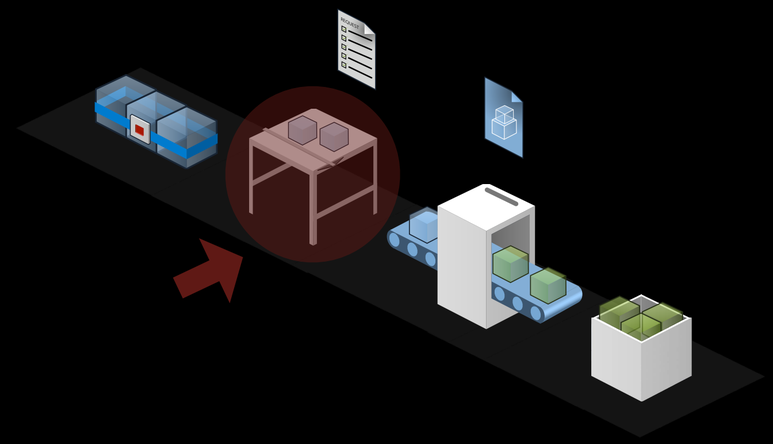
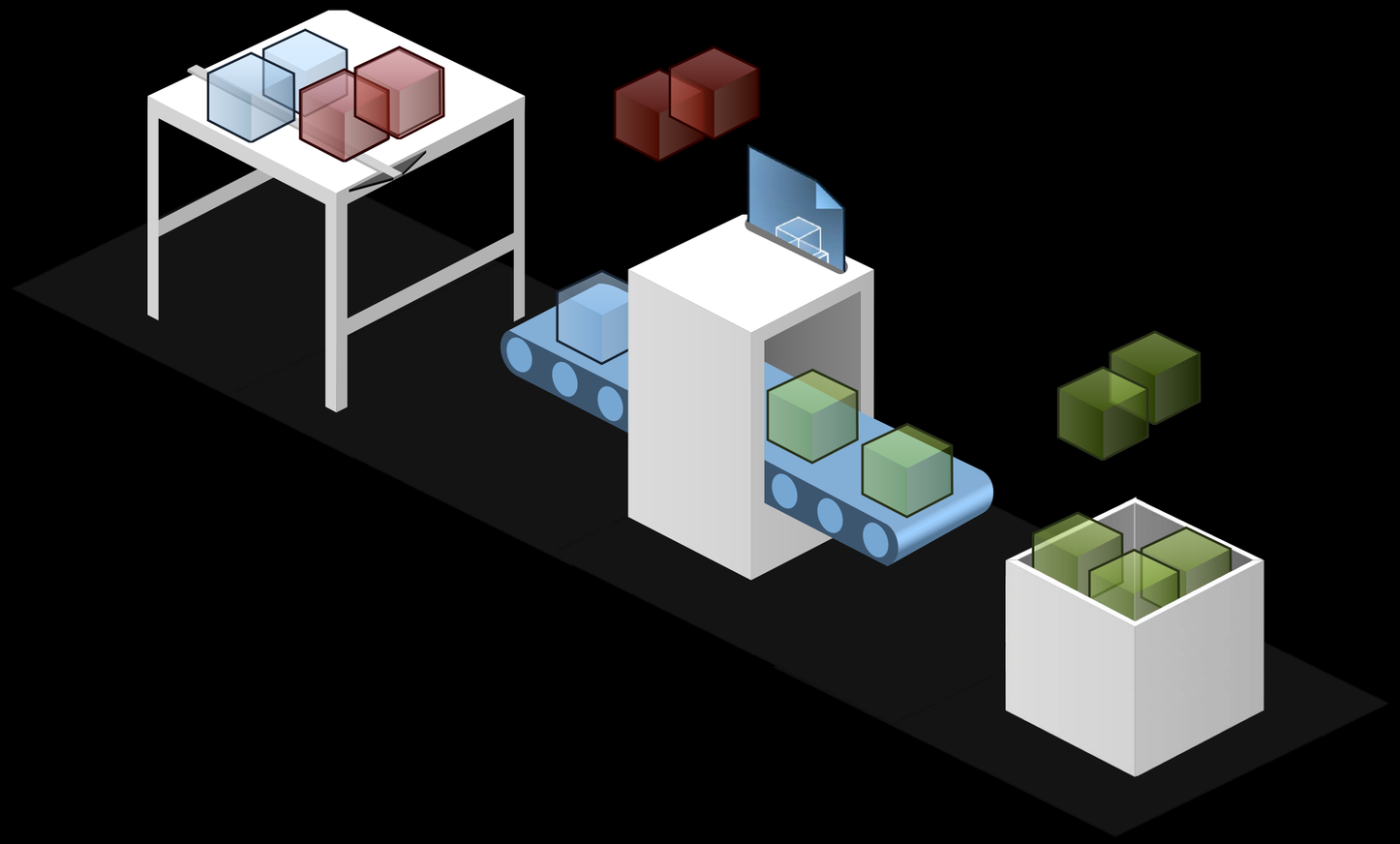


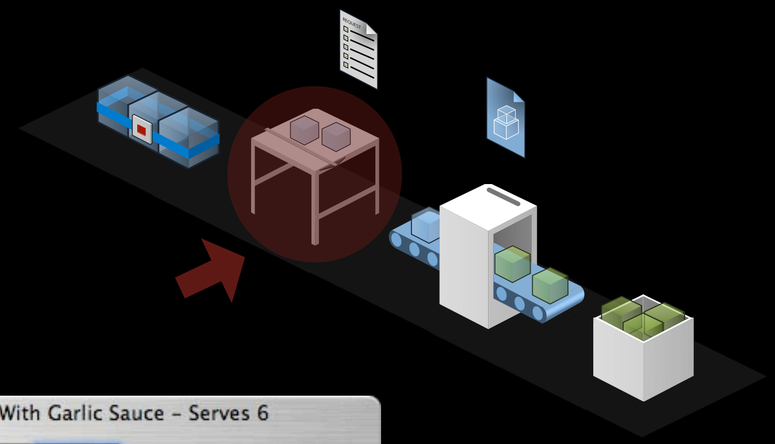


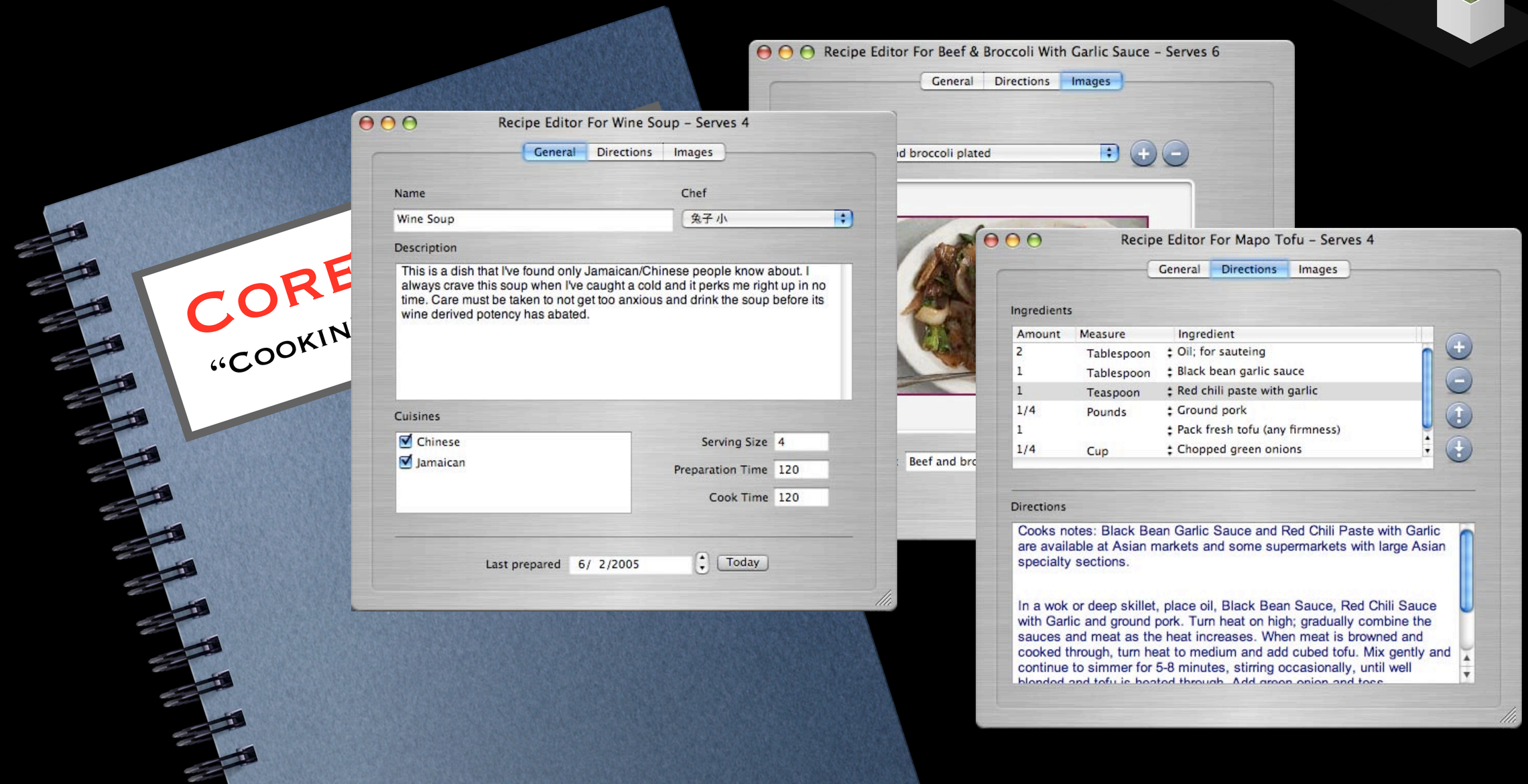
Many Edits, Many Contexts

Use multiple MOCs for your work

Core Recipes App

Uses a separate MOC per editor window





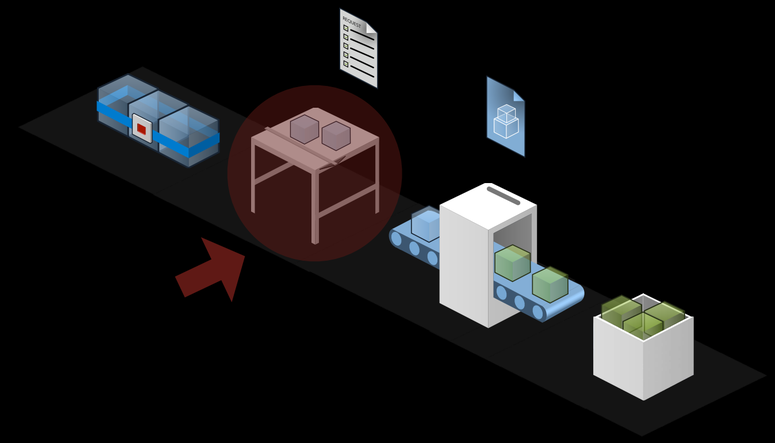
The Fetch Request

The bloodhound for your objects

http://developer.apple.com/wwdc2005/

The Fetch Request

The bloodhound for your objects



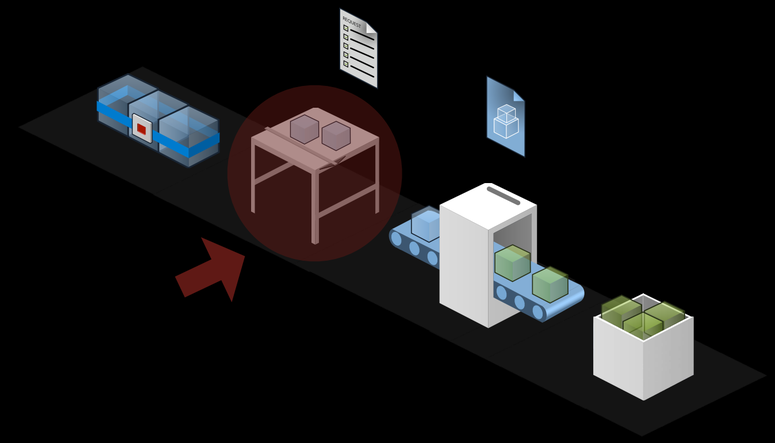
- An representation of a query operation
  - Specifies the entity to search on
  - A set of search criteria
  - Sort descriptors
- Fetch requests in models are named templates
  - Allows variable substitutions at runtime
- Evaluated in store where possible

Predicates

Defining criteria for your searches

- Predefined in model or created programmatica
- Often based on user input
- Executed in-memory or translated in persistent s
- Used outside of Core Data, too
  - Metadata API
  - Filtering in NSArrayController

Predicate Examples



Simple comparisons

```
name == “Tom”
```

Case/diacrytic insensitive lookups

```
name contains[cd] “Tom”
```

Logical operations

```
(firstName contains “a”) OR (lastName contains “a”)
```

Predicates for relationships

```
group.name matches “work*”
ALL children.age > 12
ANY children.age > 12
```

Operations

```
@sum.items.price < 1000
```

Core Recipes App

Predicates, predicates, everywhere

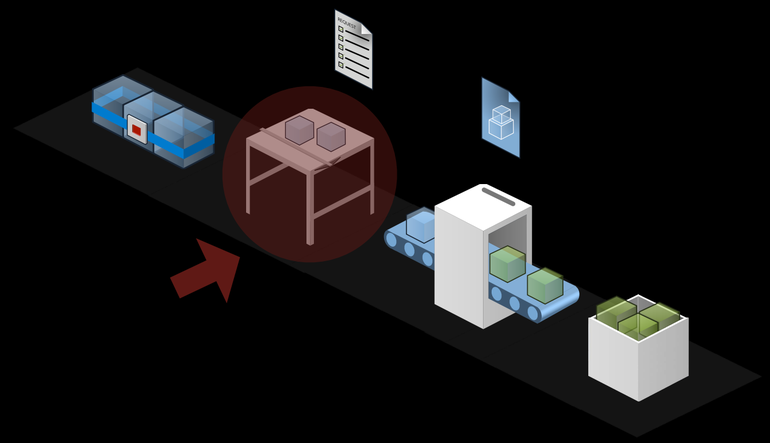
- Filter field uses compound predicates
- The “SmartGroup” entity heavily uses predicates
- Uses a predicate to find stores via Spotlight
- Has an inference engine based on predicates

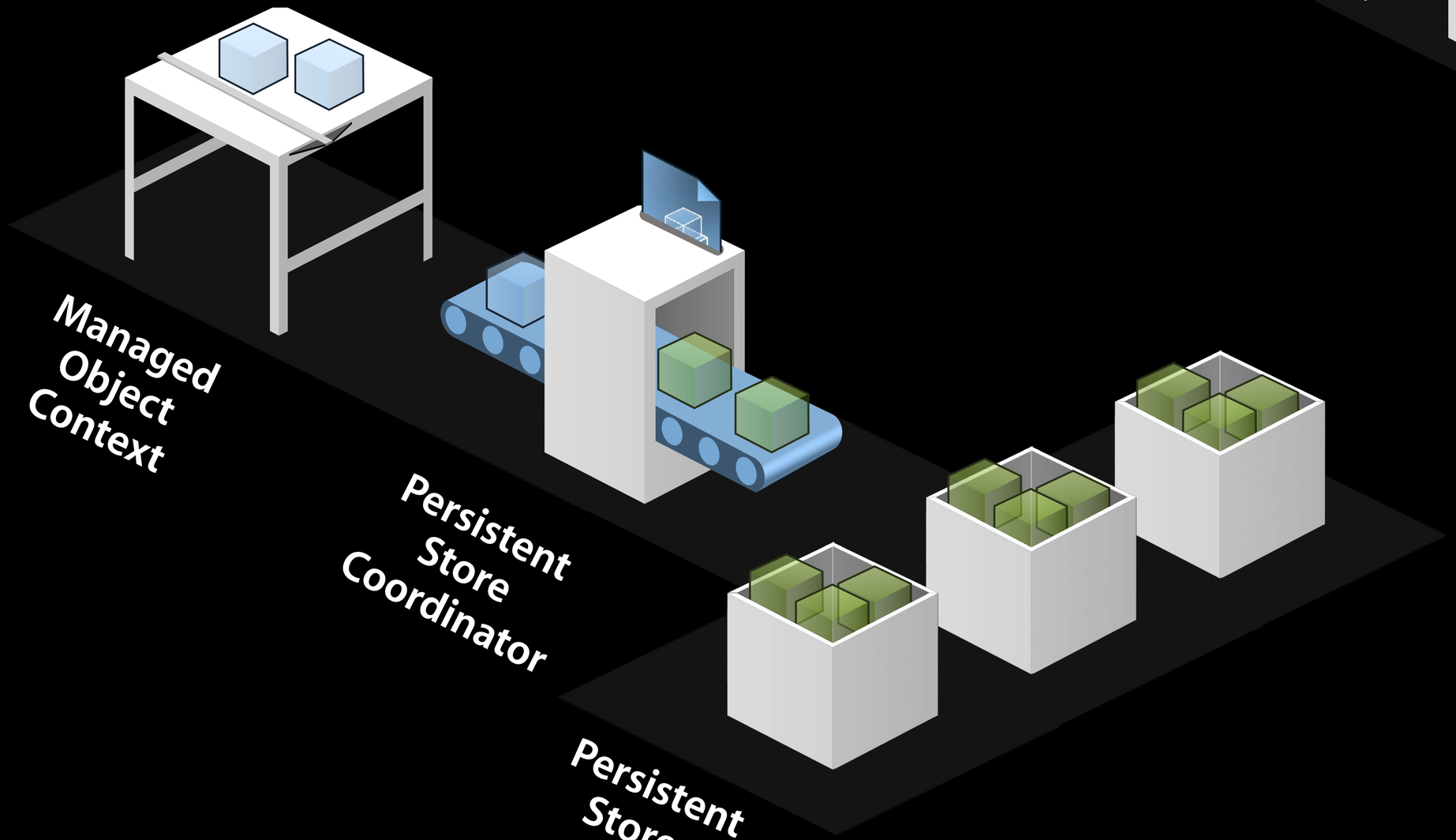
Code Snippet
(from CoreRecipesApp):

```
AppDelegate.m
InferenceCore.m
```

Processing a Fetch Request

Follow the bouncing ball





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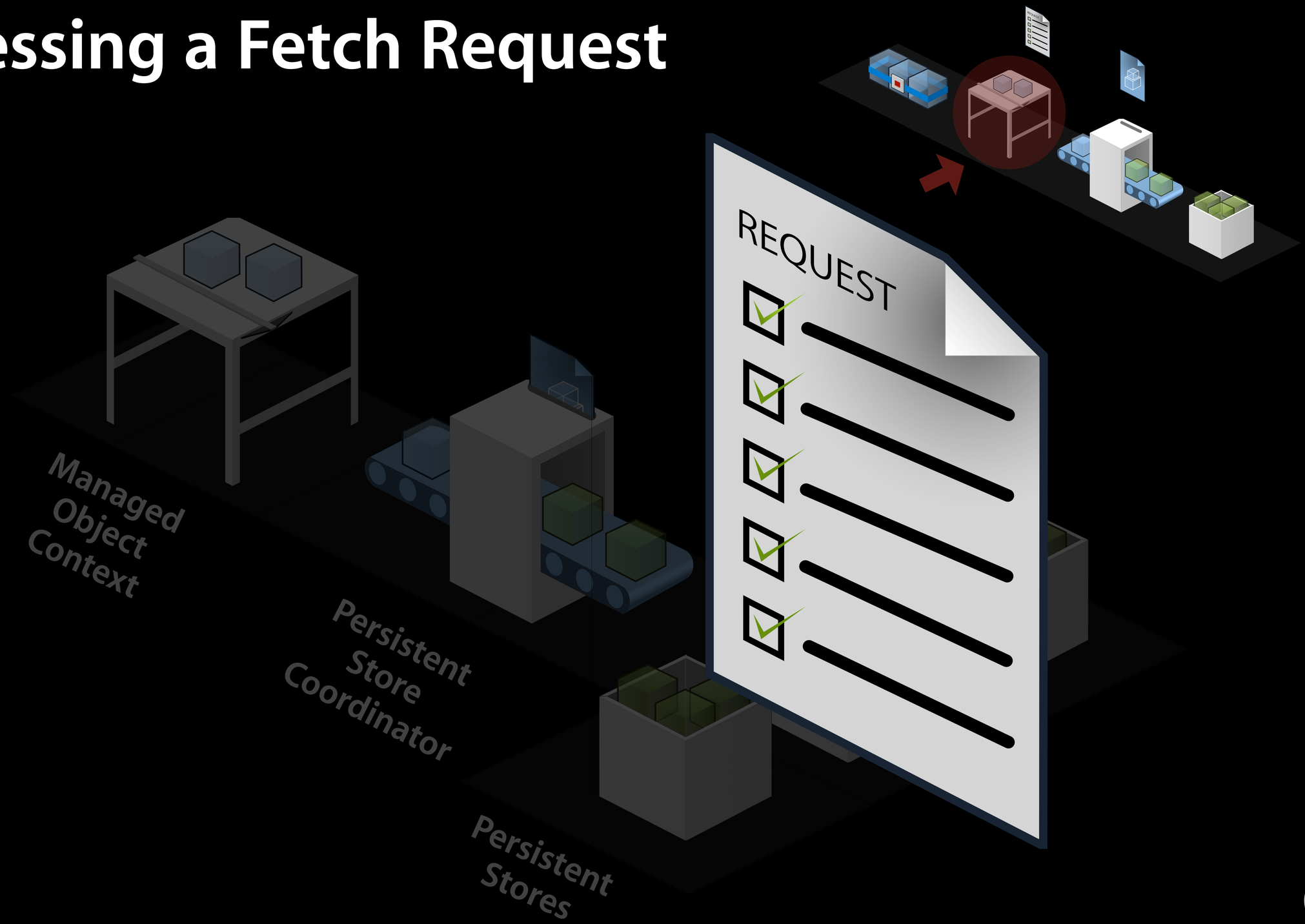

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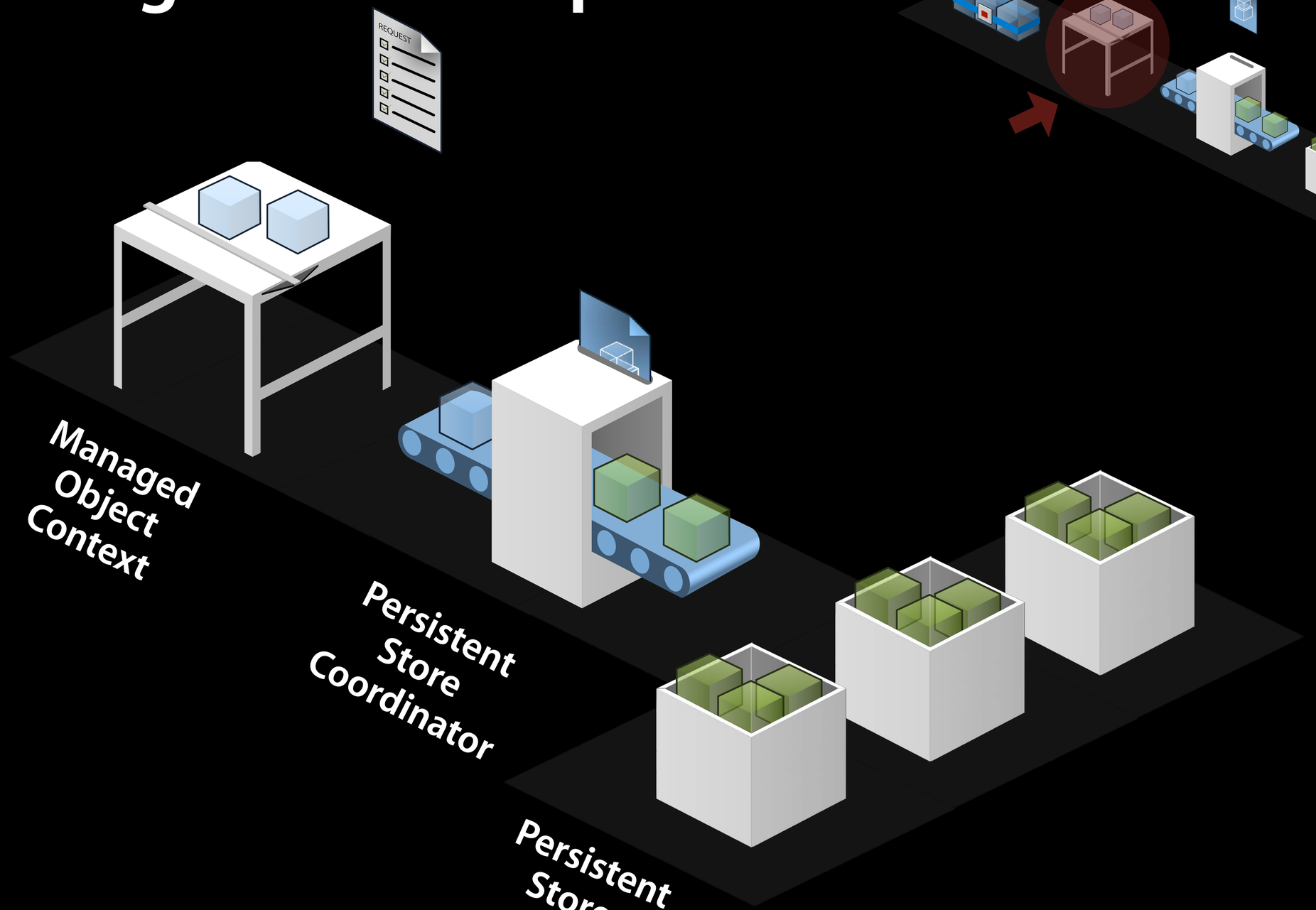

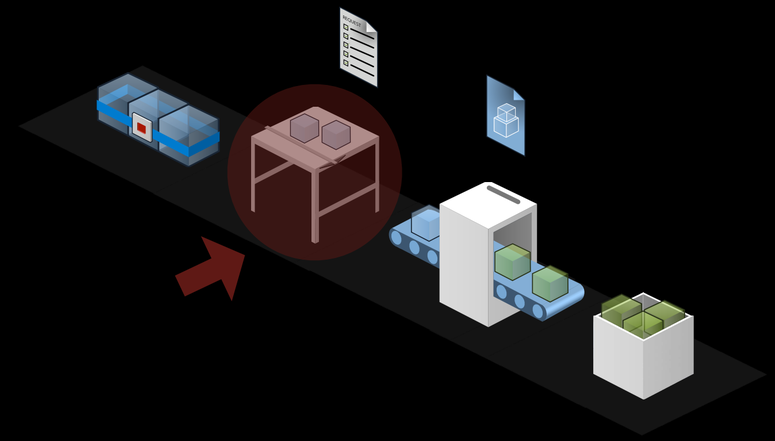

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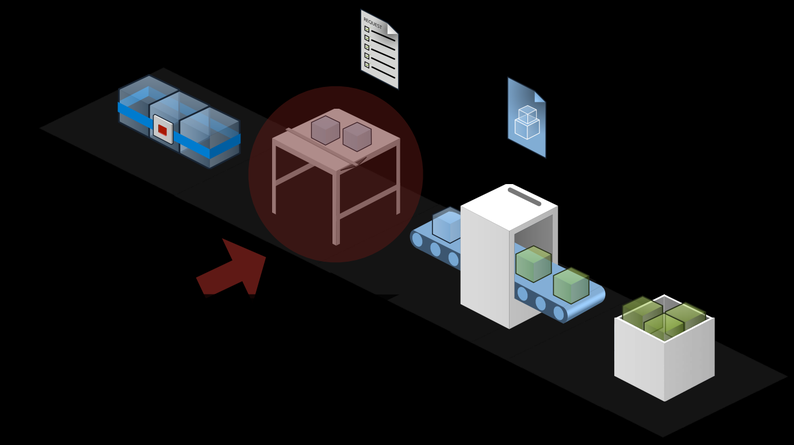

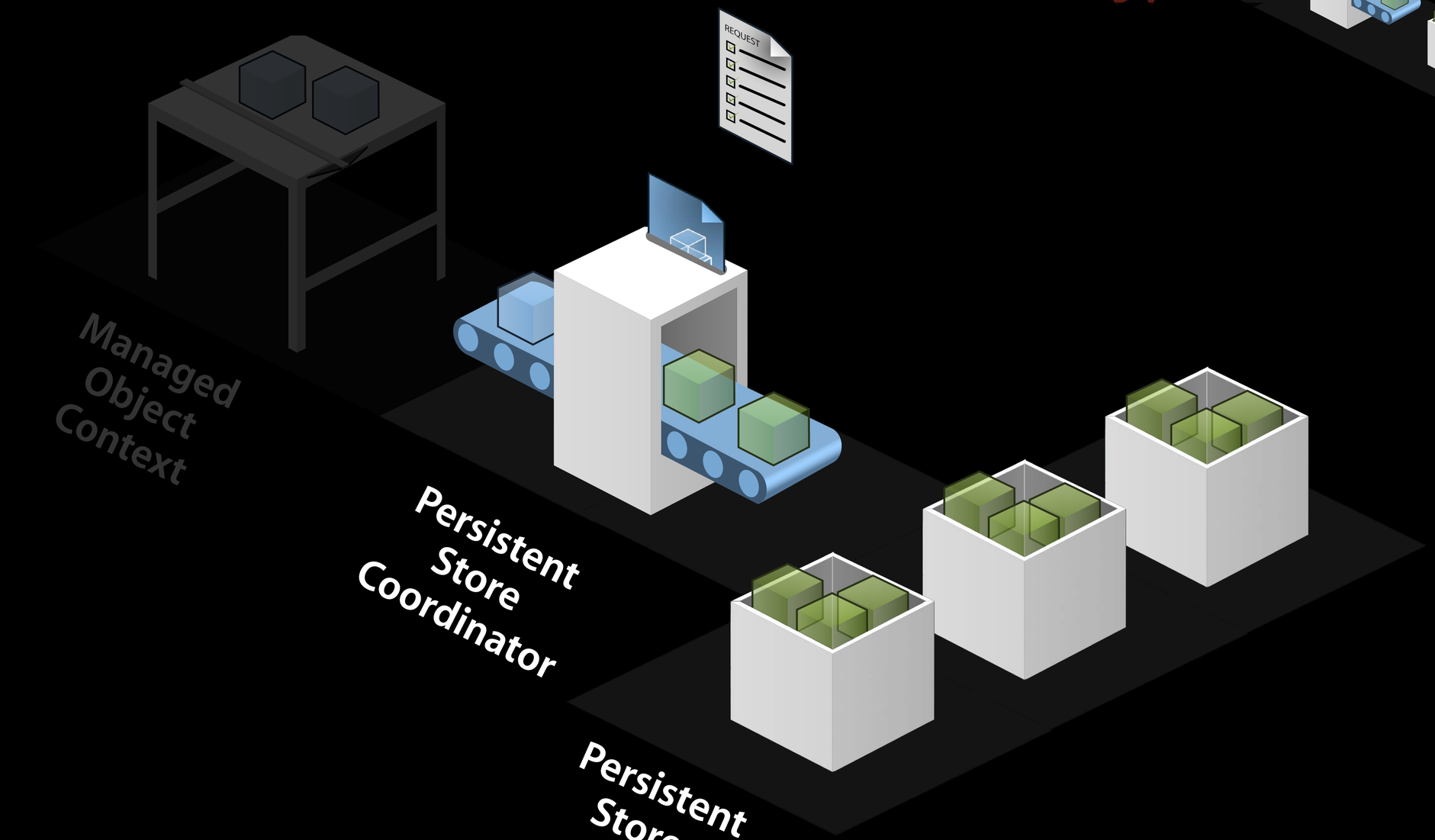

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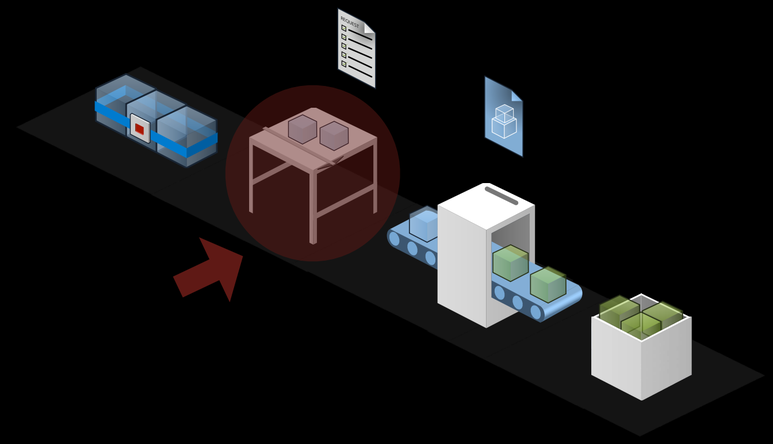

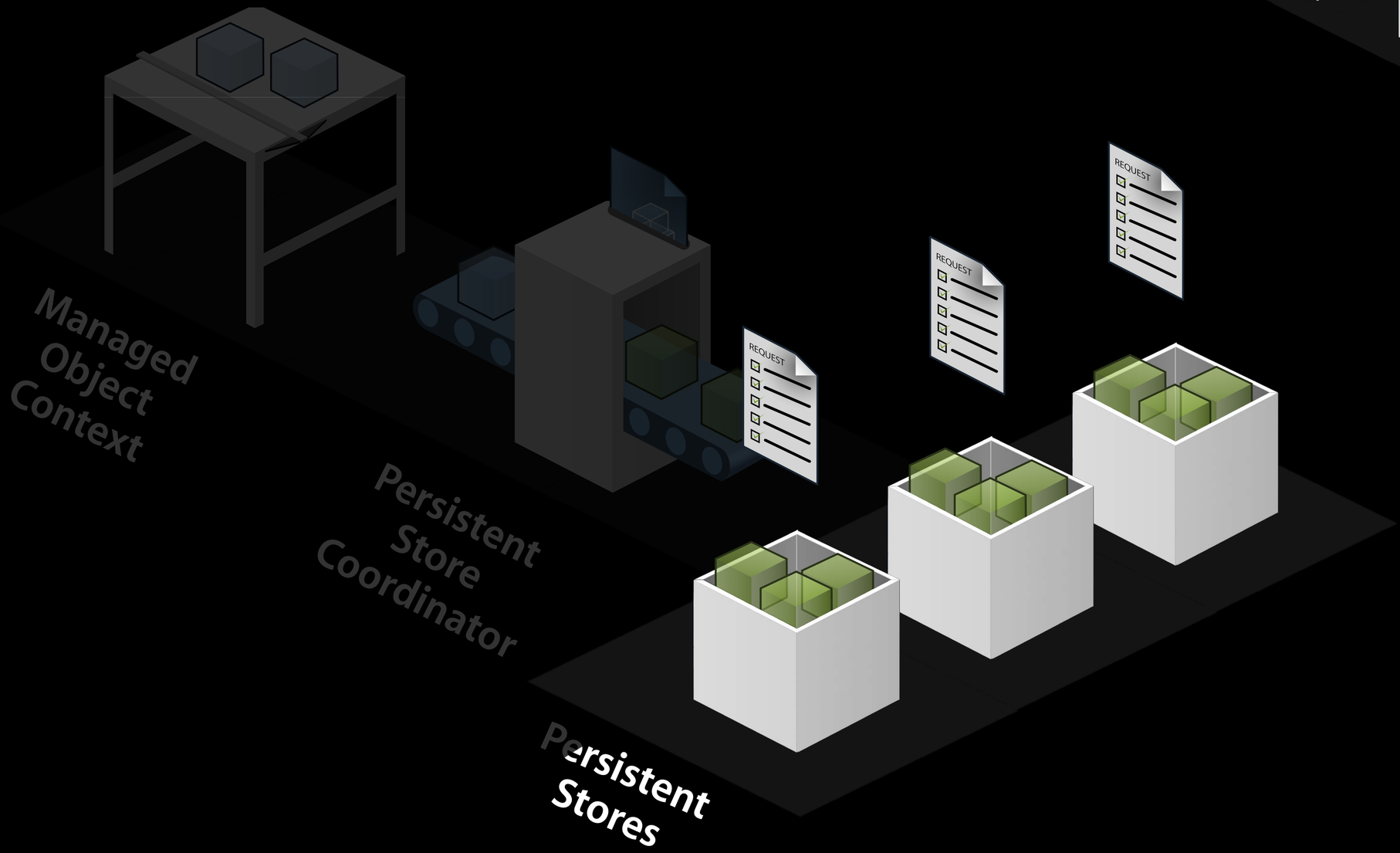

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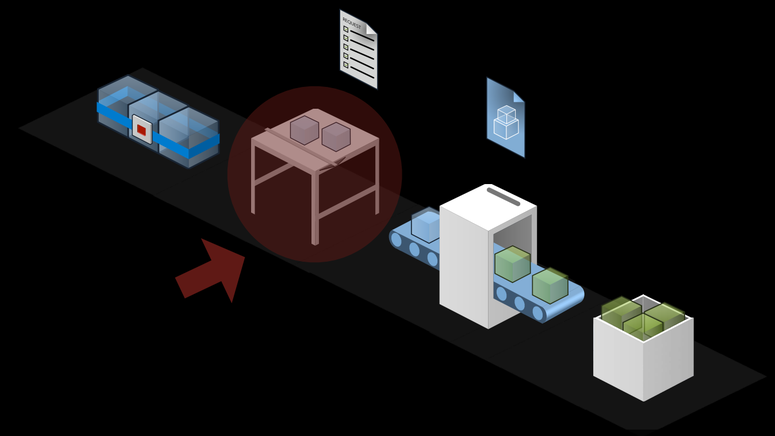

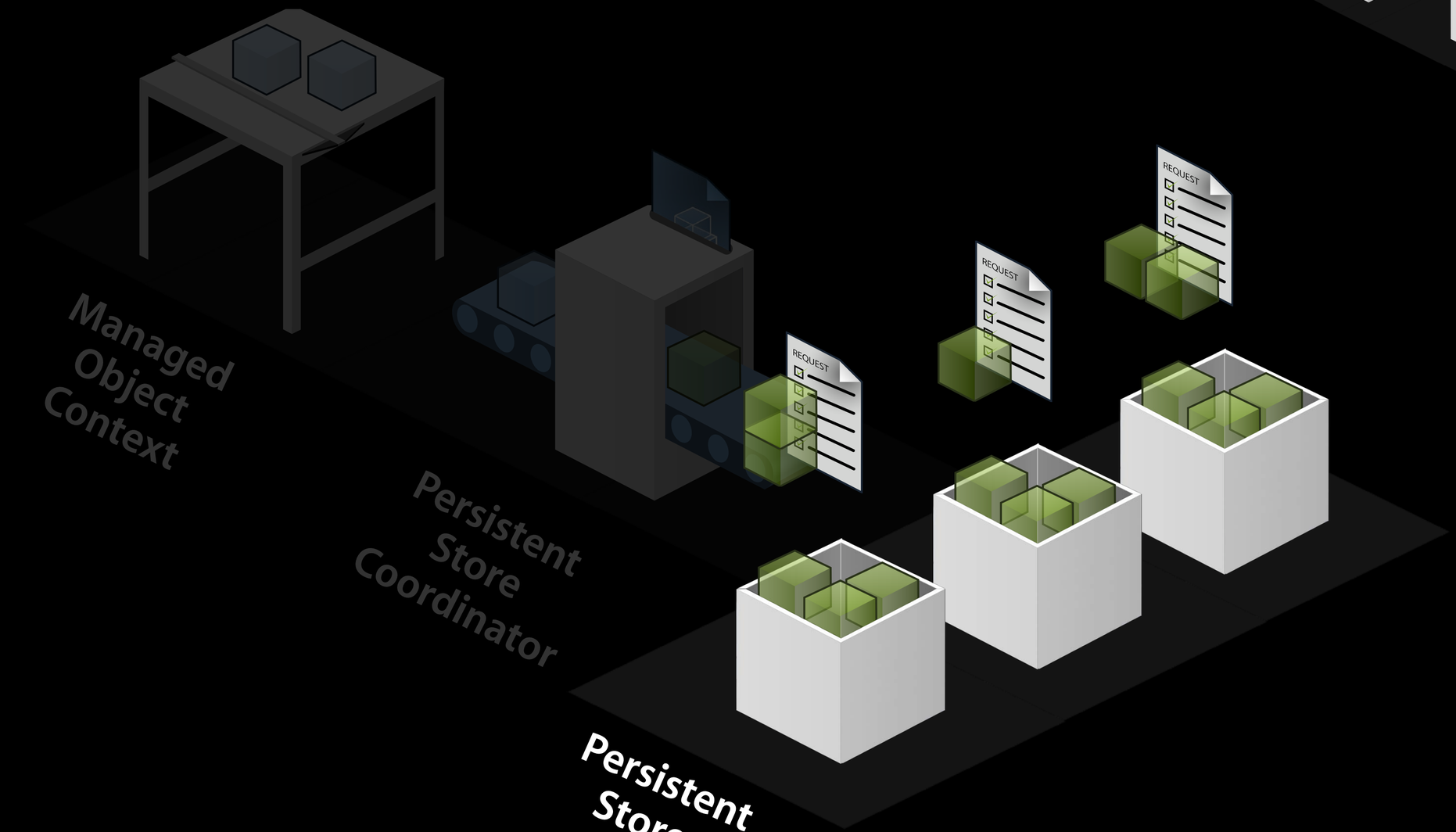

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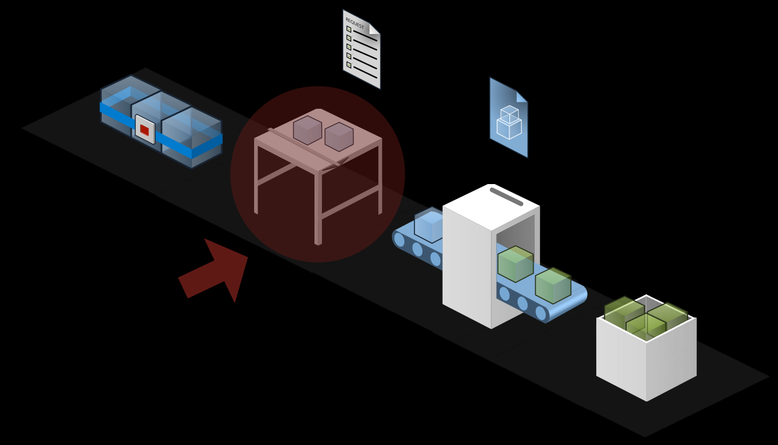

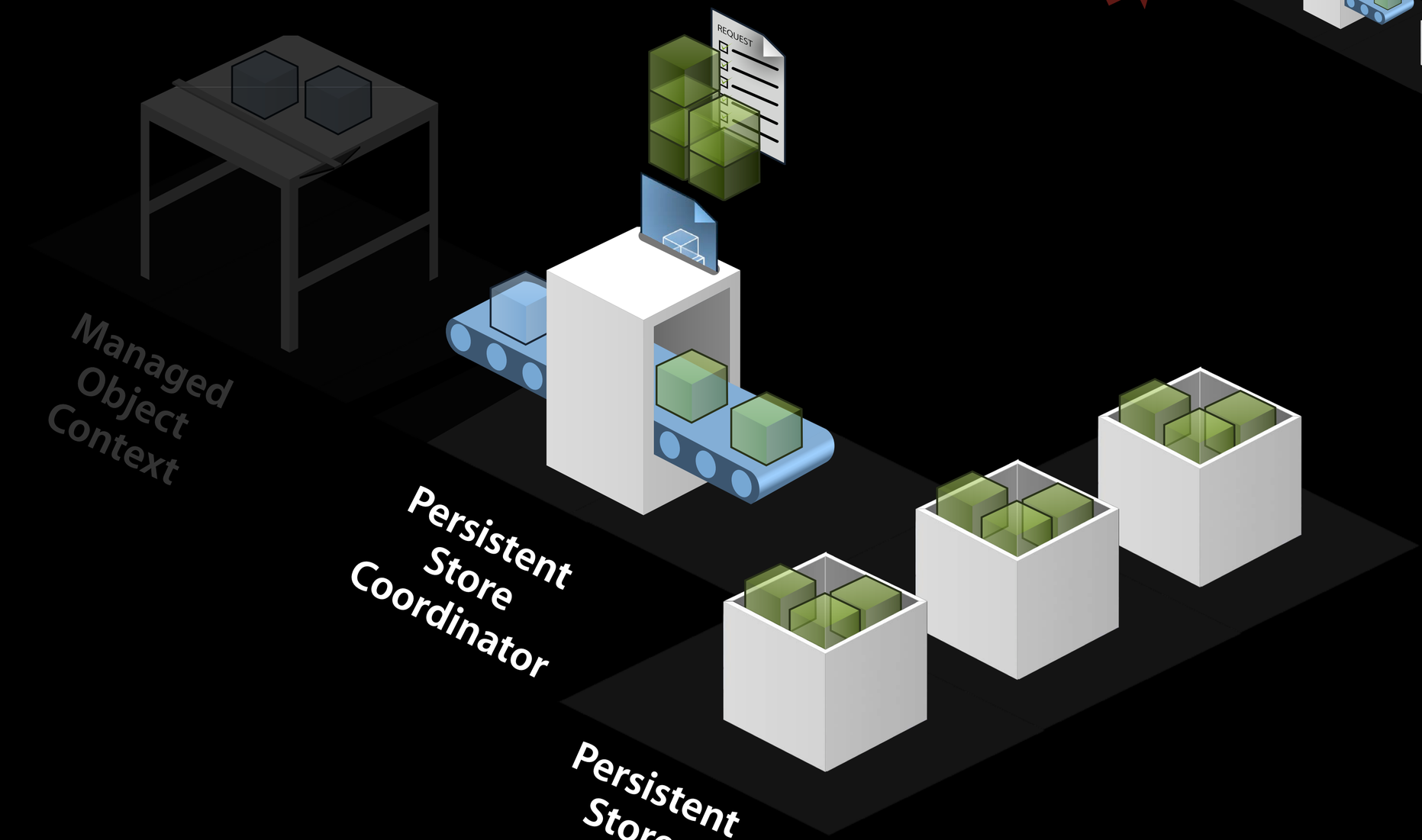

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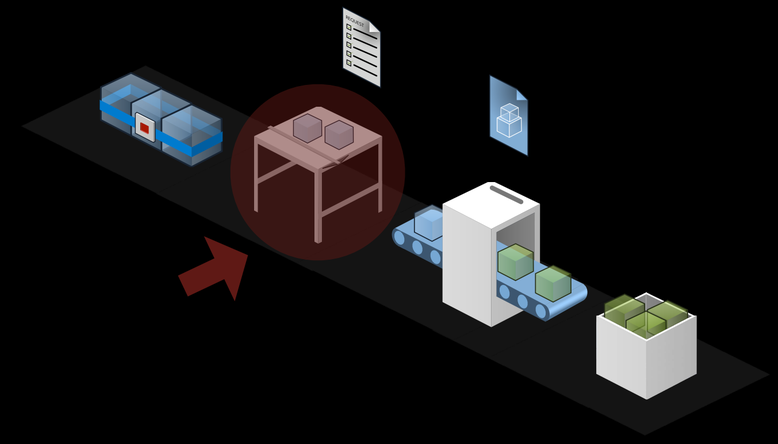

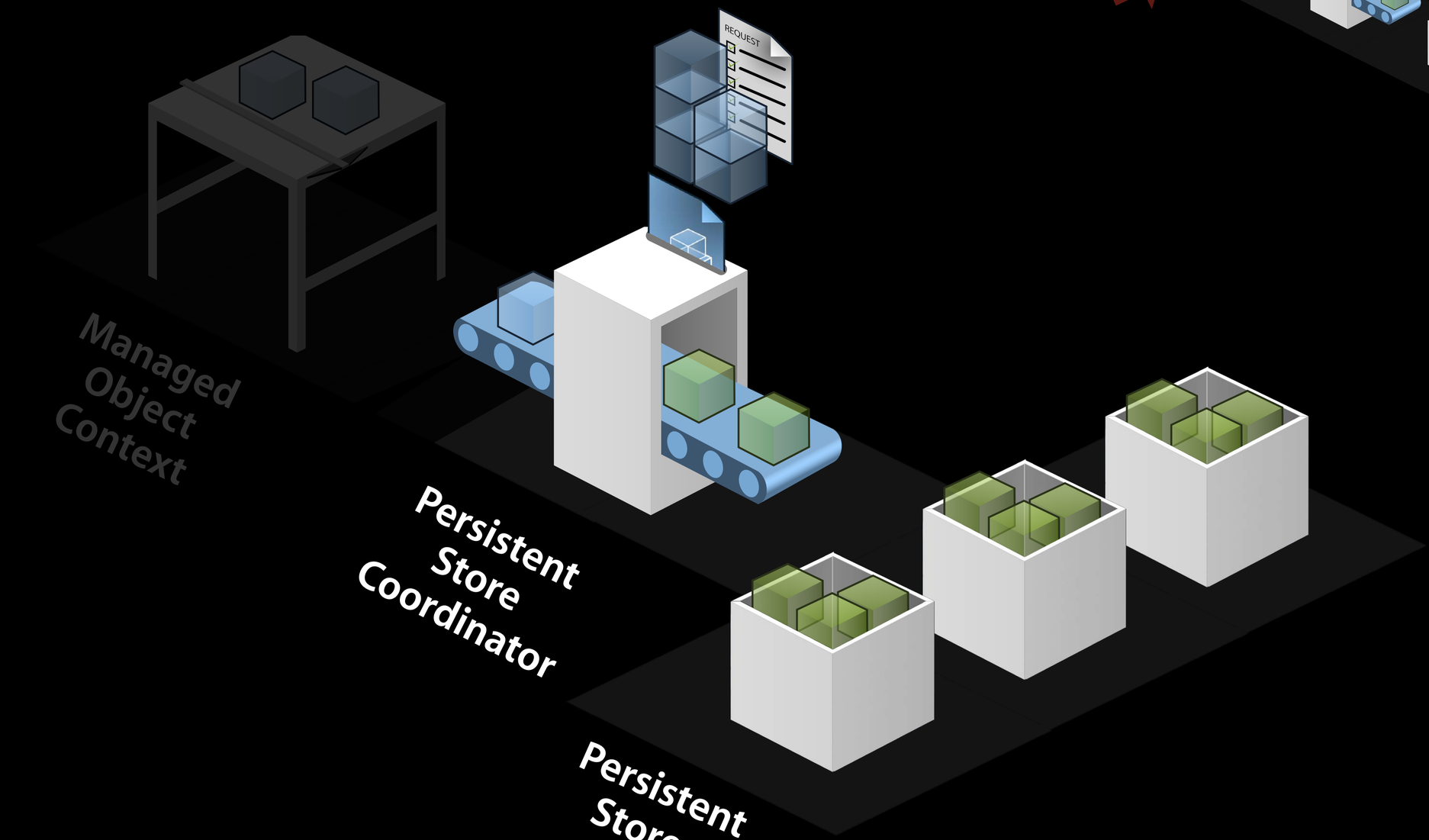

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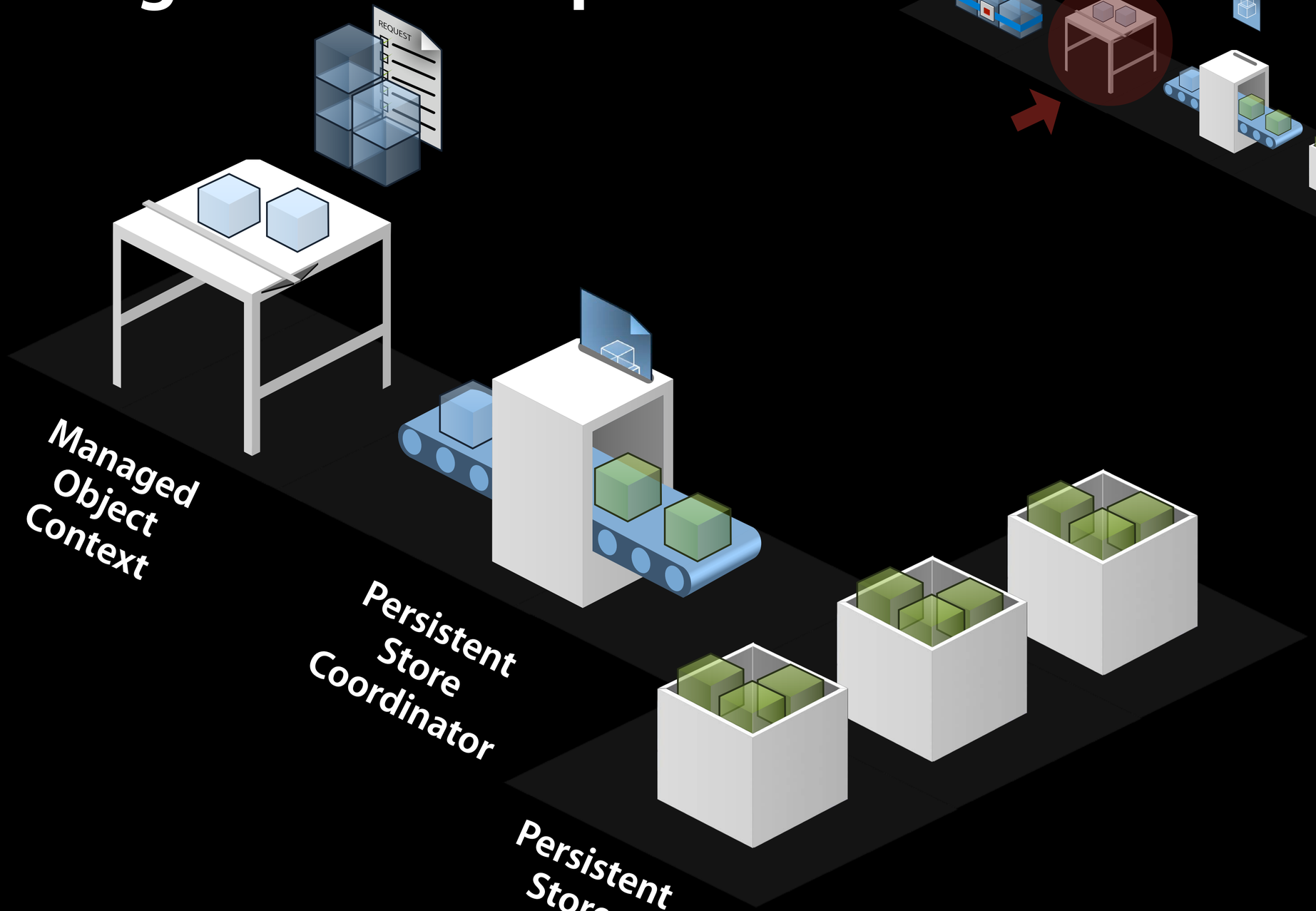
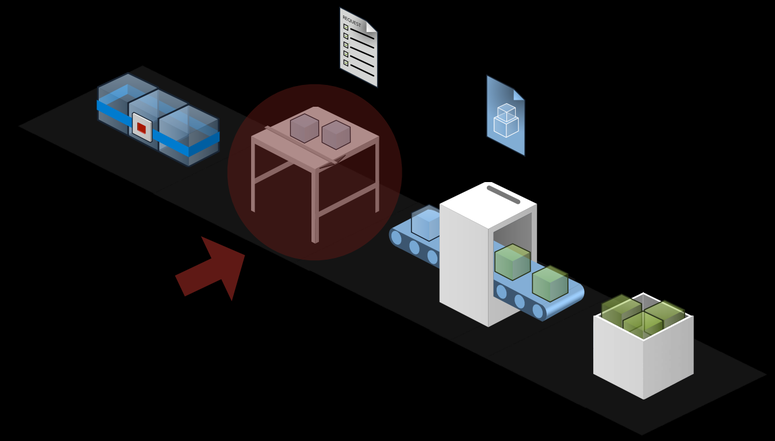
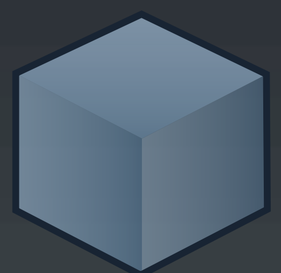






The Managed Object

Your data workhorse

http://developer.apple.com/wwdc2005/

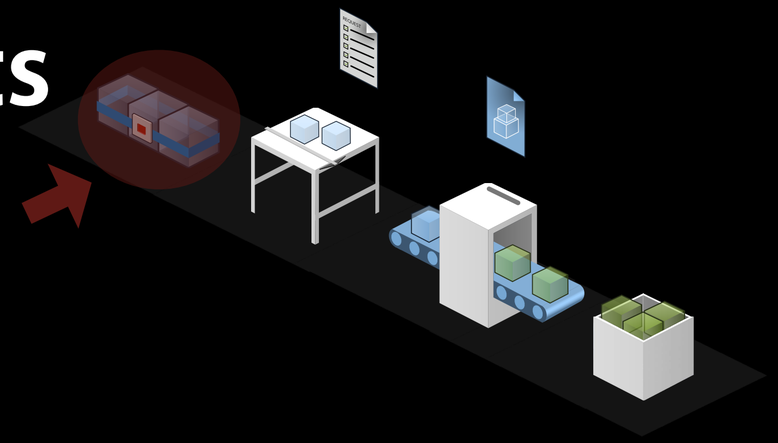
The Managed Object

Your data workhorse

- Basic unit for development and operation in Core
  - Fetch, insert, update, delete, save
- Each managed object
  - Is described by a single entity
  - Is associated with a single context
  - Has a unique ID
- Core Data provides a basic class
  - Conforms to KeyValueCoding
  - Conforms to KeyValueObserving

Making the Most of Your Objects

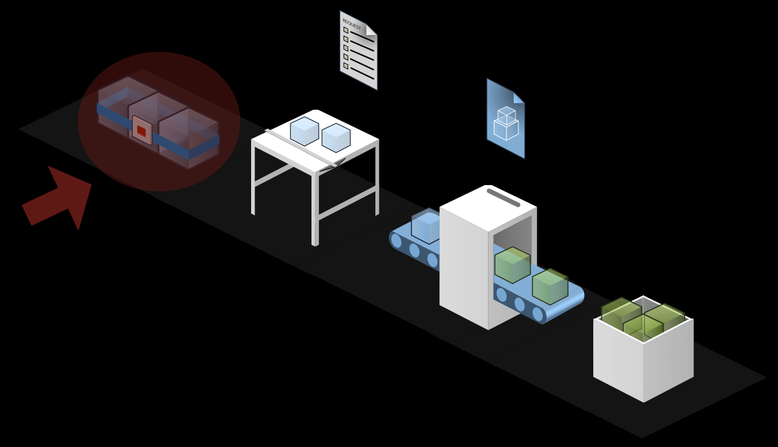
Options for adding "smarts"



- Consider where to provide functionality
  - Entity inheritance
  - Custom base class
  - Custom classes
- Use custom managed object (sub)classes for
  - Working with derived values
  - Reacting to state changes
  - Validation

Managed Object URIs

How to refer to items later



- Each managed object has a Uniform Resource Identifier (URIs) accessible via the object ID
- Can be used to refer to the object later
- Note: the URI for a temporary (unsaved) object is also temporary

Code Snippet:

CoreRecipesApp
RecipeUtilities.m
applicationURLForRecipe:

Demo

Creating a sample Core Data application

Adam Swift
Engineer, Core Data

http://developer.apple.com/wwdc2005/

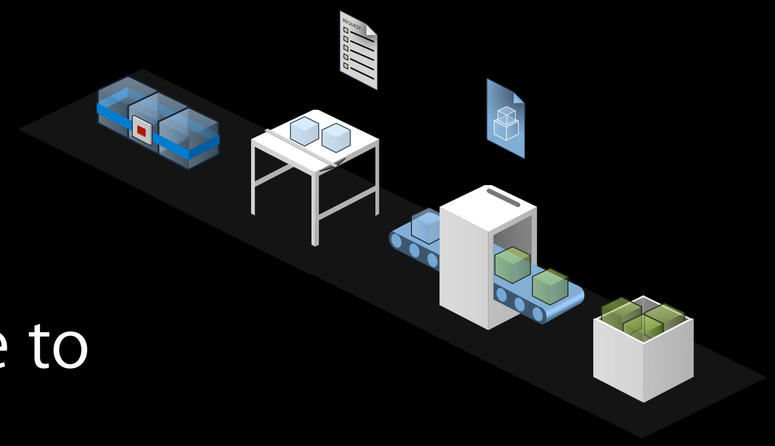
Two Common Questions

Things you might be wondering

http://developer.apple.com/wwdc2005/

Will It Be Fast Enough?

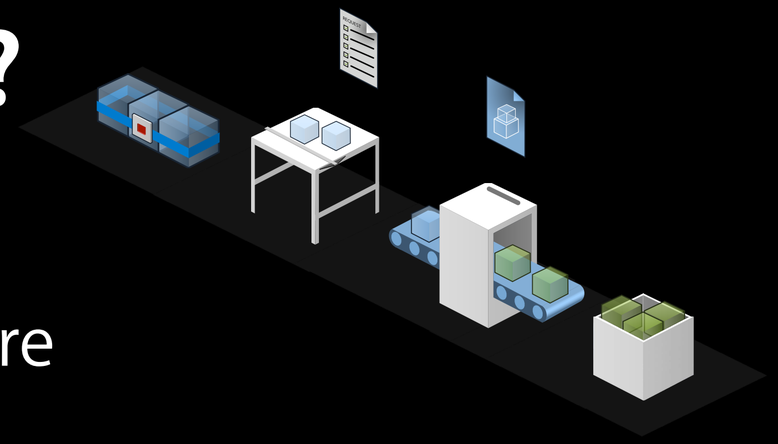
The need for speed



- In general performance tests, Core Data was able to fetch 30,000 objects in less than one second
- Put into perspective, that's more than the average
  - Number of songs in iTunes
  - Number of addresses in AddressBook
  - Number of messages in Mail

Will It Require a Lot of Memory?

My machine has a lot, but my users' don't



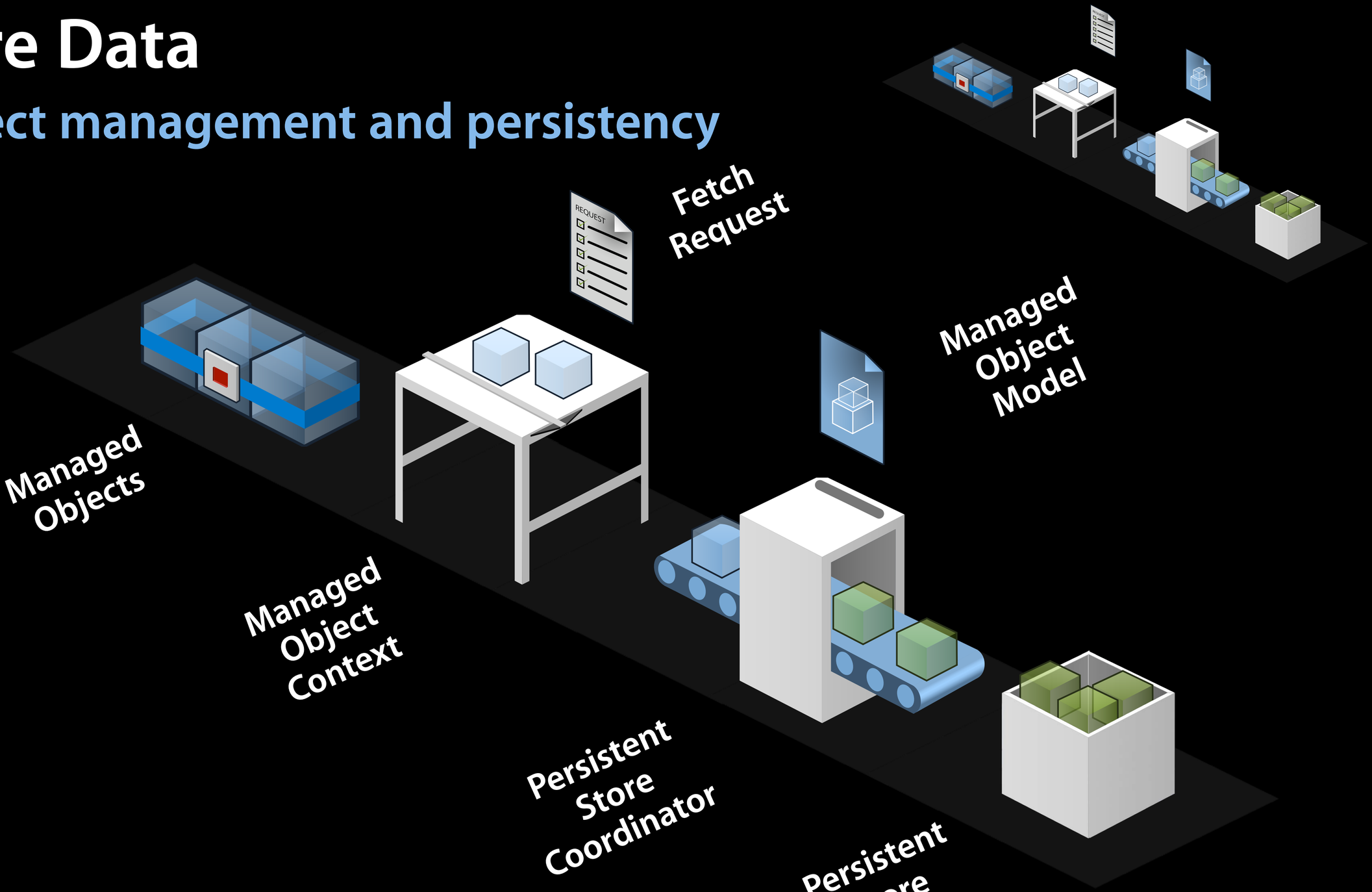
- The framework only keeps around objects that are needed in memory
  - Releases objects no longer in use
  - Grows the graph on demand
- The framework only creates objects when necessary
  - Objects from the store are "faults" until utilized
  - There is one underlying "cache" for objects

Summary

http://developer.apple.com/wwdc2005/

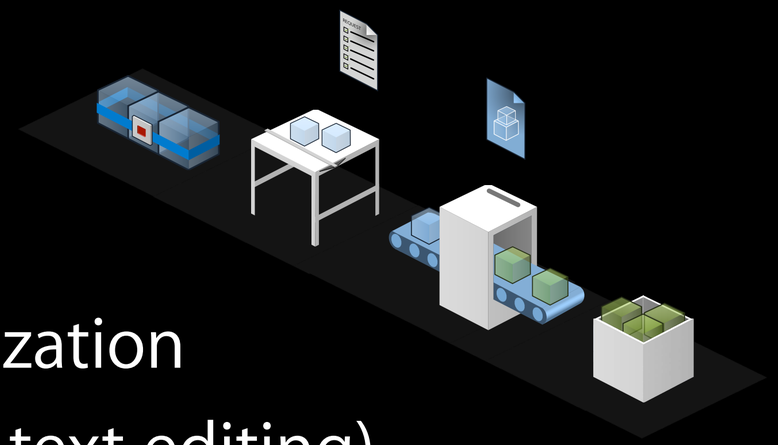
Core Data

Object management and persistency



Core Data

Object management and persistency



- Integration with Cocoa bindings for UI synchronization
- Built-in management of undo and redo (beyond text editing)
- Automatic validation of property values
- Grouping, filtering, and organizing data
- Change propagation, including maintaining consistency of relationships
- Automatic support for storing objects in external data repositories
- Several store options (SQL, XML, binary)

More Information

http://developer.apple.com/wwdc2005/

Documentation, Sample Code, and Other Resources

http://developer.apple.com/wwdc2005/

Already at Your Fingertips…

Lots of information and samples

Documentation

- Core Data Programming Guide
- NSPersistentDocument Core Data Tutorial
- Low-Level Core Data Tutorial
- Core Data Objective-C Reference (and update)

/Developer/Examples/CoreData

- OutlineEdit
- Stickies
- Tile Puzzle
- Event Manager

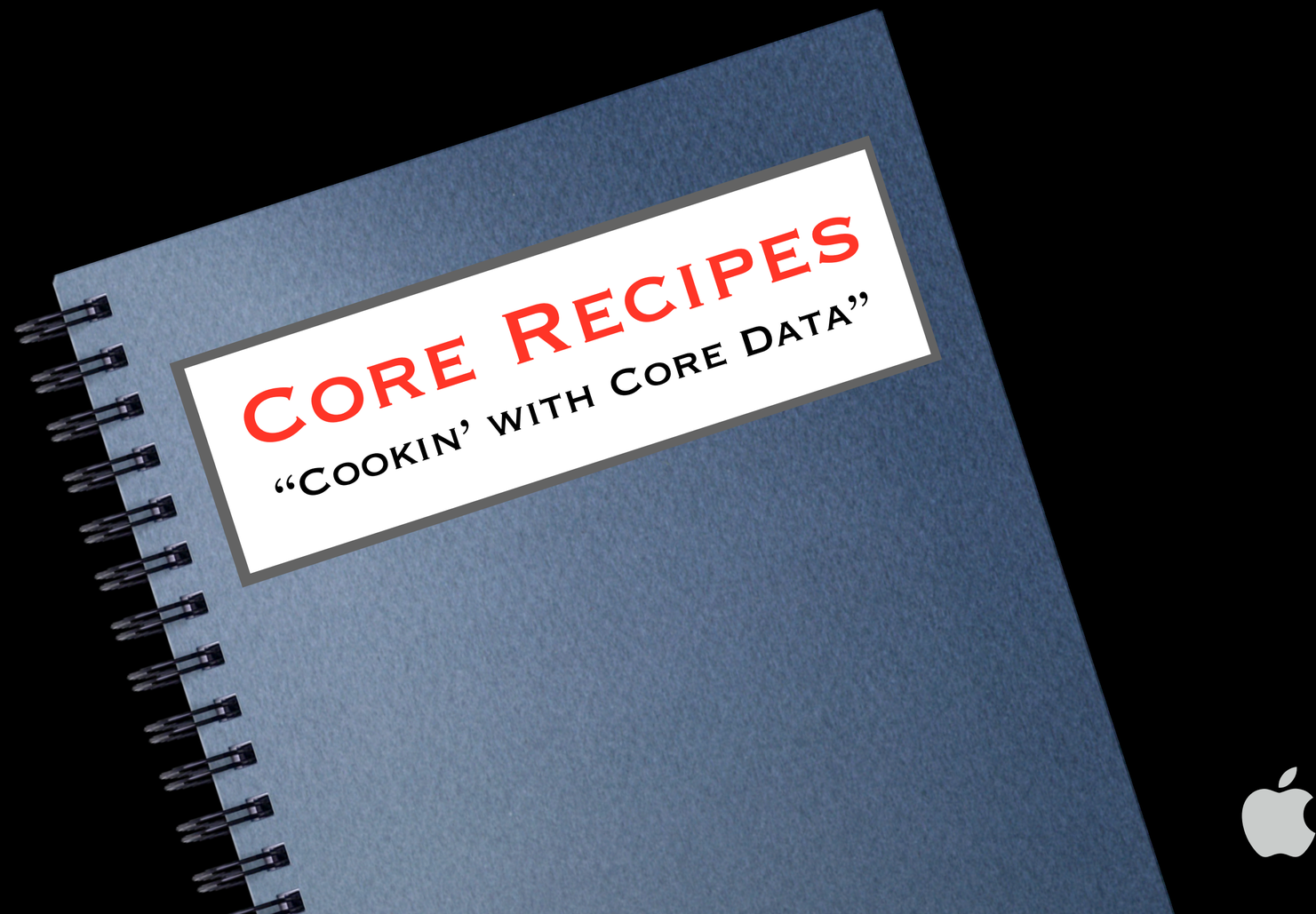
WWDC Sample Code

“CoreRecipes”

- Hands-on samples (for tomorrow’s session)
  - Command-line and GUI applications

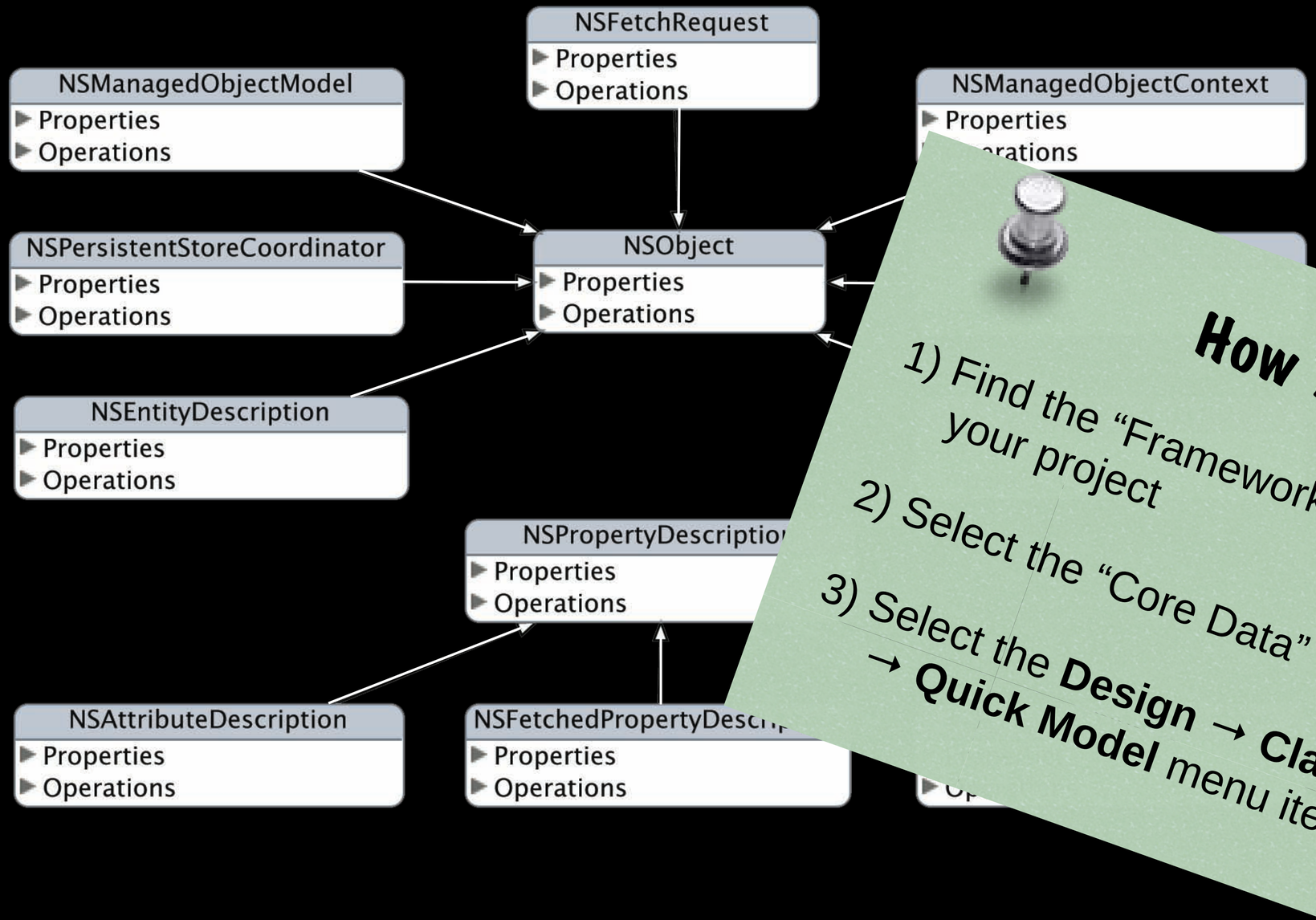
- CoreRecipes application
  - Core Data essentials
  - Cocoa bindings
  - Spotlight integration
  - Automator action

- Data migration sample



Use Xcode's *QuickModel* feature!

Visually investigate the Core Data class hierarchy



Related Sessions

Implementing Core Data	The Presidio Thursday 9:00 AM
Core Data Lab	Applications Lab Thursday 12:00 PM
Getting the Most Out of Cocoa Bindings	SOMA Thursday 2:00 PM
Core Data Lab	Applications Lab Thursday 3:30 PM
Cocoa and Core Data Feedback Forum	North Beach Friday 9:00 AM
Advanced Core Data Usages	The Marina Friday 2:00 PM

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Q&A

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http://developer.apple.com/wwdc2005/

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